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MONEL METAL

Now Produced with Higher Physical Properties

Use and Composition

Resistance to corrosion is combined with strength and toughness in Monel Metal, and the excellence with which these properties are combined accounts for the widespread and diversified use of this alloy.

Monel Metal is a nickel-copper alloy made in a modern mill fully equipped with facilities for controlling the quality and uniformity of the metal. The corrosion resistance and mechanical properties of the metal are inherent. They are not developed by heat treatment. The following chemical analysis is typical:

Nickel	68 %	Manganese	1.0 %
Copper	29 %	Silicon	.10%
Iron	1.6%	Carbon	.15%

Corrosion Resistance

Being a non-ferrous alloy, Monel Metal does not rust. Its corrosion resistant characteristics are particularly useful as they show to best advantage against the most common corrosives such as salt, dilute sulfuric acid and strong caustic soda. The metal is useful against many other corrosives, including cold dilute hydrochloric acid, hydrofluoric acid and many organic acids. It is useful against many inorganic salts, including alums, zinc chloride, and trisodium phosphate and against many organic substances such as cresol, tannins, and various solvents, including carbon tetrachloride. Other alkalies such as potassium hydroxide are successfully processed and handled with Monel Metal. As is the case with all other metals, there are some corrosives against which Monel Metal is not resistant. These include nitric acid and similar strongly oxidizing solutions.

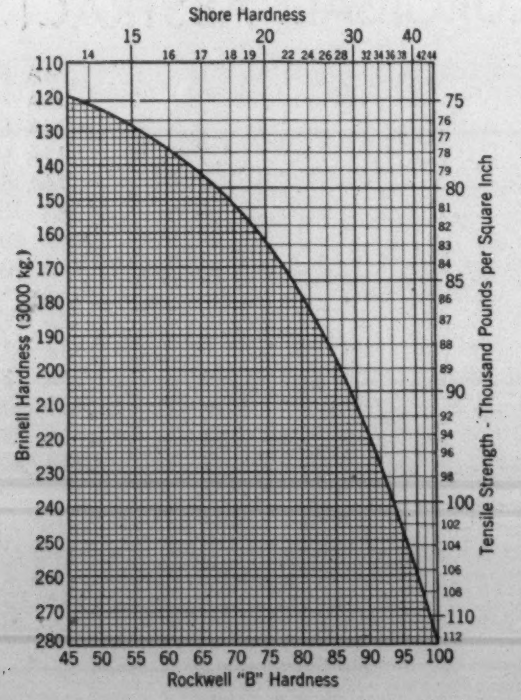
Over a period of years, much useful information on corrosion resistance has been accumulated from actual operating experience and from corrosion tests made both in the field and in the laboratory. This is available and can be brought to bear on your specific corrosion problems at your request.

To obtain information on new corrosion problems, testing devices have been developed by means of which comparative tests may be made in your equipment under the actual conditions of operation, which minimizes the danger from misleading results often obtained from various forms of accelerated corrosion tests. These devices and the assistance of experienced men are available upon request.

Physical Constants

Density	8.80 or 0.318 lb. per cu. in.
Melting Point	1350° C. or 2460° F.
Specific Heat (20-400° C)	0.127
Coefficient of Expansion (25-100° C)	0.000014
Thermal Conductivity (c.g.s.)	0.06
Electrical Resistivity	
Microhms per cm. cube at 0° C	42.5
Ohms per circular mil-foot at 0° C	256
Temperature coefficient 0.0019 per °C. or 0.0011 per °F.	
Elastic Modulus	25—26,000,000
Torsional Modulus	8—9,000,000

Approximate Relations Between Brinell, Rockwell and Shore Hardness and the Tensile Strength of Monel Metal

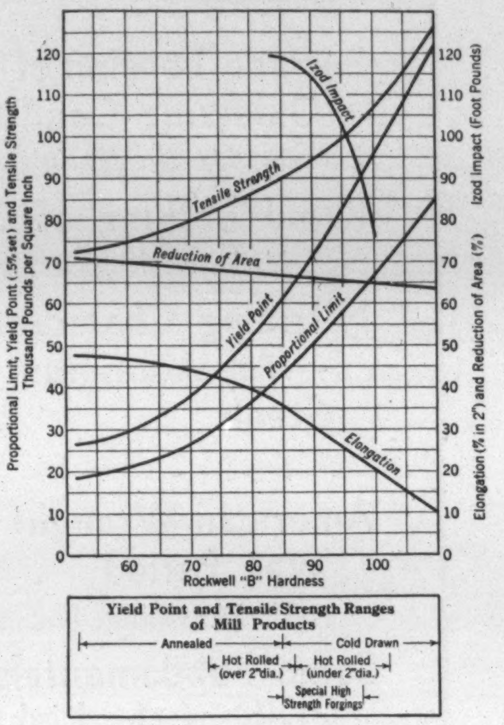


Conversions from one scale to another are made at the intercepts with the curve crossing the chart. For example, follow the horizontal line representing 200 Brinell hardness to its intersection with the conversion curve. From this point follow vertically downward for Rockwell C values (85-86) and horizontally to the right for the tensile strength (89,000)

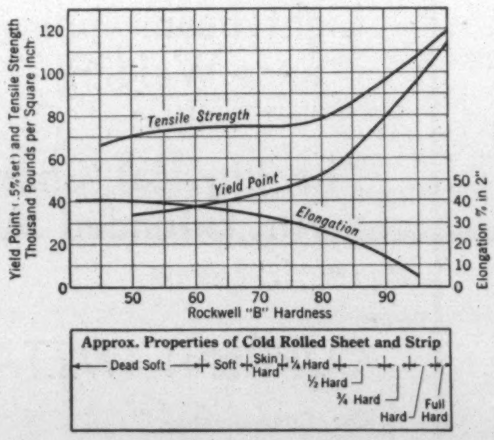
Mechanical Properties

Monel Metal is stronger and tougher than the common steels. Its mechanical properties, given in the two charts below, compare favorably with many alloy steels.

Average Properties of Monel Metal Rods and Forgings

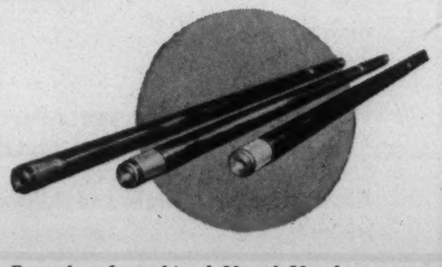


Average Properties of Monel Metal Sheet and Strip



High Strength Forgings

Special high strength forgings are supplied in Monel Metal for applications that require such strengths as were obtained in the forged Monel Metal gate stems shown below.



Forged and machined Monel Metal gate stems (6" dia. x 12'-4" long) furnished for Madden Dam

Tensile Strength	*99-103,000 p.s.i.*
Yield Point	*73-78,500 p.s.i.*
Elongation (% in 2")	*30.1—36.0*
Reduction of Area (%)	*57.9—65.0*

Endurance and Corrosion Fatigue

The endurance limit is 37,000 p.s.i. for annealed Monel Metal. Cold working the metal raises the endurance limit to as much as 53,000 p.s.i.

The corrosion fatigue tests of McAdam have shown that Monel Metal specimens exposed to brackish river water withstand 6 x 10^7 cycles at 1450 R.P.M. when stressed to 31,000 p.s.i., which compares with 8,000 p.s.i. for carbon steel.

Availability and Fabrication

Monel Metal is available in all the usual mill forms and as bolts, nails, screws, cotter pins and many other accessories. The metal can be fabricated readily and joined by the usual methods. Printed instructions on various fabrication operations are available on request. These are supplemented by a welding and fabricating service available to fabricators and users of Monel Metal.

Welding, Brazing and Soldering: Monel Metal is weldable by all regular methods, including flash and seam welding. Plain and flux coated wire for gas and electric welding are distributed through the same channels as the metal.

Monel Metal is silver soldered with Easy-flow Brazing Alloy (MP-1175° F.) or Grade RT Silver Solder (MP-1325° F.) using Handy Flux, all of which are supplied by Handy and Harmon, 82 Fulton Street, New York, N. Y. Brazing is done with bronze welding rod using Inco Gas Welding and Brazing Flux. Soft soldering is done with 50-50 solder using a zinc chloride base soldering flux.

Machineability: Monel Metal is machineable. Because of the great toughness of the metal, slower cutting speeds and lighter cuts are made, using tools of tough high speed steel that are ground with sharper angles and honed. Sulfurized mineral oil is used abundantly as a lubricant for boring, etc., and is preferred for all work, though water soluble oils suffice for lathe work.

Special grades of free machining Monel Metal are available for automatic machine work where high cutting speeds must be maintained. Free machining qualities are, of course, obtained with a sacrifice of toughness and some sacrifice of strength and hot ductility, but without impairing the corrosion resistance.

Forging: Practically any shape forgable in steel can be forged in Monel Metal. The recommended forging range is 1750-2100° F. Proper heating is important and it is essential to avoid exposing the hot metal to sulfurous heating atmospheres or other sources of sulfur. The heating atmosphere in contact with the metal should be reducing in character, i.e., 2-5% excess CO.

Drawing and Stamping: The practice for Monel Metal closely follows the practice for steel. The same die materials are satisfactory, except carbon steel. Use a lubricant with high film strength, such as beef tallow or castor oil, and avoid lubricants containing sulfur or lead, if annealing is necessary. Anneal after 35-50% reduction of diameter.

Spinning: Monel Metal spins like steel but more easily. Lay the metal down on hard chucks using long powerful strokes and avoid reworking as much as possible. Use tallow for lubricant and avoid soft steel tools. Always anneal before network of fine cracks develops on outer surface.

Annealing: Clean off any lubricant, paint marks, etc., before annealing. Softening begins at 1200° F. and proceeds rapidly above 1600° F. Prolonged heating above 1600° F. develops large grain size, which is not desirable. See notes on heating under Forging.

Magnetic Properties

Monel Metal is slightly magnetic at temperatures below its transformation point, which is around 200° F. Permeability is affected considerably by mechanical and thermal treatment and by composition. A magnetizing force of 60 Gausses induces a flux density of approximately 1300 Gausses in annealed Monel Metal rods and sheets, but the flux density may be deviated as much as 750 Gausses by mechanical and thermal treatment.

Effect of Temperature on Properties

The properties of Monel Metal are not much affected by temperatures up to 750° F. Short time tensile tests show a practically straight line drop in tensile strength from 70,000 p.s.i. at 800° F. to 10,000 p.s.i. at 1500° F. The limiting creep stress is 45,000 p.s.i. at 800° F., 15,000 p.s.i. at 1,000° F. and about 3,000 p.s.i. at 1200° F.

The toughness of Monel Metal is not diminished by lowering the temperature. Izod impact tests made at —300° F. yield the same values as at room temperature. At the low temperature, the tensile strength, yield point and elongation are approximately 40% higher.

Literature

Technical bulletins giving more detailed information on the properties of Monel Metal are available on request. Send for List B showing all bulletins and other literature on Monel Metal and Rolled Nickel. If interested also in nickel steels, nickel cast iron, nickel bronzes, etc., ask for List A as well.

Copies of this page are available in loose-leaf form. Send for yours.

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

HIGHLIGHTS

Written by the Abstract Section Editors and the Editorial Staff

Using Equilibrium Diagrams

Practical metallurgists will find helpful Kalling's methods (page MA 88 L 2) for applying equilibrium diagrams and fundamental data to plant problems.—A.H.E.

Health Baths of H_2S Water!

Stoecker (page MA 88 L 7) advocates utilization of the H_2S-charged water in which blast furnace slag is granulated for "health baths." We are curious as to how this is to be commercialized. After the requirements of the steel mill workers, and the town, for H_2S baths are met there might still be a surplus of the water. Will it be canned and shipped, or will excursions be run to the steel mill? Nice job for a specialty salesman, but he needn't call on us. H_2S baths and sauerkraut juice may be healthful, but someone else may have ours. —H.W.G.

How to Handle an Alloy Packing for Pistons

Lippert (page MA 90 L 2) describes methods employed at the South Altoona shops of the Pennsylvania Railroad in melting and casting of a packing material (60 Pb-2 Ni-38 Cu) for locomotive pistons.—G.L.C.

Cast Iron Chills High in Graphite

According to Fröhlich (page MA 90 L 3) cast iron chills for bronze castings are better if they are high in graphite.—H.W.G.

German Progress in Making Plate Direct from Hot Metal

Bleckman reports progress in Germany on freezing a flat stream of steel as it is fed to a pair of copper rolls, producing plate without going through the ingot stages (page MA 96 L 2). But he says there are still bugs to be overcome.—H.W.G.

Torsional Strength of Zinc Plated Screws

Zinc plated screws have high torsional strength says Mabb (page MA 97 L 1).—H.W.G.

Open Hearth Developments

Trinks believes (page MA 101 L 2) that recent developments in continuous automatic control of open-hearth temperatures will greatly hasten the general adoption of open-hearth furnace insulation.—M.H.M.

DO YOU want to know what metallurgical engineers are saying, the world over? Look in the Current Metallurgical Abstracts. Here are some of the points covered by authors whose articles are abstracted in this issue.

The War on Oxidation

Recent developments and new installations of furnaces for scale-free hardening, annealing and brazing are described by Wynne (page MA 101 L 3).—M.H.M.

Large Scale Wear Testing of Rails

The application of "wear tests" on a large scale has been started by the Lehigh Valley R. R. to recondition the surface of rails in the track which have become badly worn as a result of service (page MA 108 R 8). —H.S.R.

Simultaneous Electrodeposition of Two or More Metals

The electrodeposition of two or more metals simultaneously as an alloy has generally been possible only in a few special cases. According to a recent German patent, however, this can be done quite easily by a proper control of voltage and current density (page MA 109 L 3). These are varied in a pulsating or rhythmical manner so as to give for an instant the optimum condition for each of the metals in rapid succession. Au-Cu-Ni and Ag-Cu-Ni of high hardness have been made in this manner. —H.S.R.

Seeing Inside Test Pieces

The flow of material in the interior of an aluminum compression specimen can be made visible by X-ray radiographs, if small tungsten wires are imbedded in the specimen before deformation according to Tanaka and Matano (page MA 110 L 2).—C.S.B.

Medicine for Strained Metallurgical Nerves

An apparatus used in physiological researches on nerves and muscles of the human body has recently been adapted by Coker (page MA 110 R 6) to the measurements of temperature changes occurring in metals resulting from varying stresses. The apparatus gives a true maximum reading in 3 or 4 seconds, thus minimizing the heat losses resulting from conduction and radiation.—W.A.T.

Identification Tests for Aluminum

There are rapid tests available for distinguishing between pure aluminum and its alloys, also between copper bearing alloys and copper free alloys, says von Zeerleder (page MA 110 L 3). A scratch with an aluminum wire and a drop of NaOH does the trick.—C.S.B.

More Data on Corrosion

For a comprehensive review of the work on corrosion being conducted in different lands, particularly on copper steel, read the abstract of the article by J. C. Hudson (page MA 123 L 3). —V.V.K.

The Question of Ornamental Plumbing

Devillaire (page MA 126 L 8) considers Cu plumbing to be more "ornamental" than iron piping. Artistic judgments are likely to be highly variable, but had never classed exposed plumbing as decorative. Why lug in such an argument to accompany the technical ones?—H.W.G.

Alloys Comparable with Phosphor-Bronze

According to Gill (page MA 126 L 10) cadmium alloyed with 3.1% Cu makes a bearing comparable with the best commercial phosphor-bronze. Pilling (page MA 126 L 9) suggests cadmium with 2% Ni.—G.L.C.

"Zero Notch Sensitivity" of Duralumin

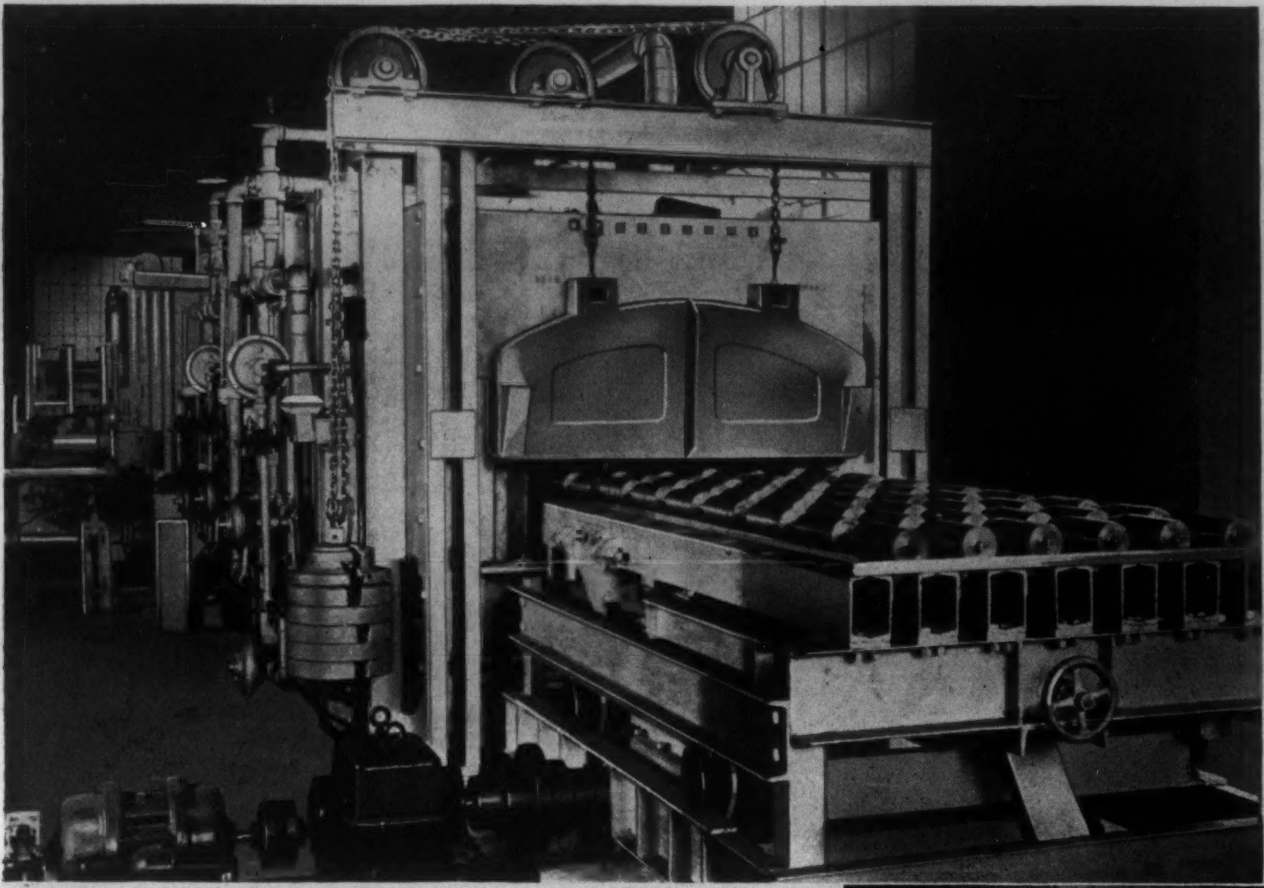
We fear that Aitchison's (page MA 126 R 3) statement, as reported in the abstract, that heat-treated duralumin has "zero notch sensitivity," is not surrounded with the qualifications required in an extended discussion. We recall too clearly a case of failure, of a duralumin-type airplane propeller, in flight at surface notches caused by stamping the patent number on the blade (see Metals & Alloys, Vol. 2, Feb. 1931, pages 72-73) to let this go without comment.— H.W.G.

Mill Bearings of Pb-Ca-Na Alloys

Aleksandrov and Igonkin advocate the use of Pb base bearings containing up to 1% of Ca and Na for merchant mill bearings (page MA 126 R 5). Power consumption is less and life appreciably longer than when Sn base babbitt is used.—G.L.C.

Paving Blocks of Cast Iron

Cast iron paving blocks, which are being tried out in Europe, are also being tried in a street on the University of Minnesota campus (page MA 127 R 9).—H.W.G.

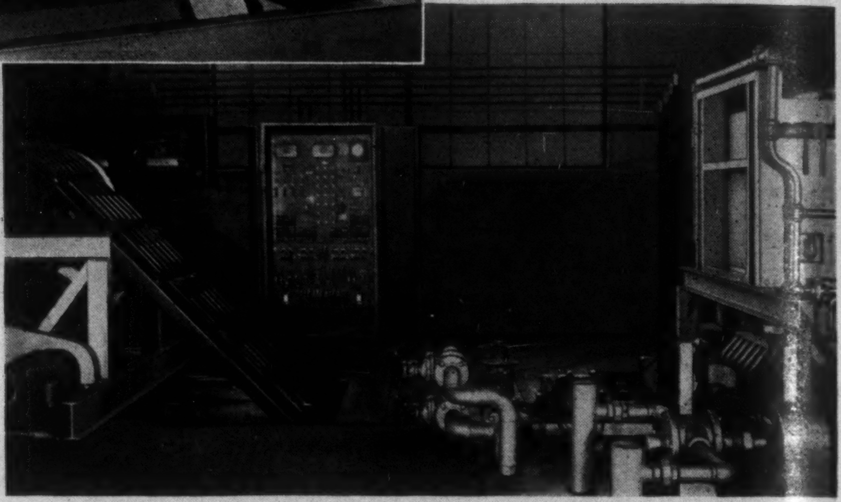


Left: Charge table and charge end, S. C. Continuous Walking Beam Type Hardening Furnace. Drawing Furnace is visible in left background.

Below: Discharge end Hardening Furnace at extreme right, control panel in center background and conveyor from quench bath (center foreground) to Drawing Furnace at left.

The two furnaces are entirely automatically operated. Inside diameter thoroughly quenched, automatically.

There is no difference between the hardness of the inside surface and the outside surface of the cylinders, which are open on one end only.



IMPROVED the specified physical requirements!
SURPASSED all results previously obtained!

The SC Gas-Fired Hardening and Drawing Units illustrated above were installed by a well known eastern manufacturer. This installation is now a part of the production line, and is producing results that surpass any previous accomplishments, even to the extent of showing considerable improvement over their specifications, set up as the desired standard.

Atmosphere Conditioning burners are used. These burners make possible a surface condition on the cylinders that shows less scale than previously. Also, the surface is such that machining can be done to better advantage.

The manufacturer, in describing the operation of these two furnaces, stated that "They are writing a new chapter in our production records."

Write for further information.

Controlled Atmosphere Furnaces

Surface Combustion Corporation

SC

TOLEDO, OHIO

Sales and Engineering Service in Principal Cities

Also makers of.. ATMOSPHERE FURNACES... HARDENING, DRAWING, NORMALIZING
ANNEALING FURNACES... FOR CONTINUOUS OR BATCH OPERATION

EDITORIAL COMMENT

Comforts of the Exact Sciences

SCIENCE HAS BEEN defined as that in which we can believe what the other chap tells us, and which we can use and build upon. The definition could also be applied to engineering. We like it, for it includes only the "exact sciences" and excludes the near-sciences, such as economics, sociology and so-called "political science."

It is certainly a relief to turn from most of the articles in magazines like Harper's and from the "serious" articles in most of the daily newspapers that deal with politics and economics, to the articles in scientific and technical journals.

The politico-economic writers cannot state proven facts; they can only state what they think. What they think is often colored by the wishes of some superior. We can't even be sure that they say what they think in their own hearts, for the whole thing may be merely a trial balloon sent up by a politician with an ax to grind. One reads reports of Russian plans and alleged accomplishments, Nazi propaganda pamphlets, accounts of Japanese naval rantings, and emanations from the alphabetical agencies of our own administration, with the knowledge that much of it all is just wishful thinking.

Yet in spite of Soviets and dictators who exercise censorship or bias the thinking of the politicians and economists, the people of all countries are willing to read (in original or in abstract) the articles by, and to accept without question the findings of, workers in the exact sciences no matter where they live. We all read what has been published in the various Russian journals, in the Archiv, the Tohôku Memoirs, and the Bureau of Standards' *Journal of Research* with complete confidence that it represents the authors' true belief. We know that the scientists of any country will continue to report their findings impartially and with integrity, for such findings are not biased by the desires of any administration; they rest on facts which we can check experimentally for ourselves if we wish to.

To an encouraging extent this is true even of engineering advertising, for claims made for properties of a new alloy or a new furnace can be checked up by exact methods, and sooner or later will be, so honesty is the best policy. Moreover, when trying to sell things to scientists and engineers it is wise to know just what the attributes of those things are, for the prospective purchasers will demand that information and won't buy till they get it.

Even the annual "features" in the automobile game, designed to appeal to the non-technical buyer, such as free-wheeling and stream-lining, are no mysteries or marvels to the engineer, and the automotive engineers themselves talk and write frankly about the very small value of some of the fashion-features that are stressed by the sales departments. They don't kid themselves and they don't themselves react to propaganda, only to demonstrable facts.

It is certainly a comfort to perform editorial duties in the scrutiny of articles on metallurgical science and engineering, for there is so little propaganda and wishful thinking to contend with, and what little there is, is easily detected and cast out. We'd hate to have to attempt to sort the wheat from the chaff in any of the non-exact "sciences."—H. W. GILLETT.

The "Patience" of Metals

THE TERMS "CREEP" and "flow" are in use in English-speaking countries for the slow deformation of metals under constant load at elevated temperatures, while the Germans use two rather similar words, "Dauerstandfestigkeit"—long-time stability—for creep, and "Dauerfestigkeit"—long-time strength—for endurance or fatigue, though once in a long while, a German author with a desire for abbreviation, uses the latter term when he means the former. In browsing through Vol. 13 of *Transactions* of the American Institute of Mining Engineers for February 1884—June 1885, we found, pages 646-656, an article by Henry Marion Howe, entitled "The Patience of Copper and Silver as Affected by Annealing" in which he studied the ability of these metals, annealed and cold-worked, to withstand prolonged loading at room temperature.

He discussed also some experiments on iron by Robert Henry Thurston. Howe clearly showed the rapid initial stretch, followed by strain-hardening and diminution of creep characteristic of present day creep curves, taken within the strain-hardening range. He ran his tests for about nine months and concluded that some of his curves indicated that, if they continued at their final rate, it would take some centuries for failure to ensue.

In a foot note he remarked that "endurance" might be a better term than "patience." "Creep" is doubtless a still better term, especially as "endurance" has come to refer to behavior under repeated, rather than sustained, stress.

Howe's terminology is not particularly admirable, but Howe himself had a most admirable insight into the behavior of metals. Time after time, in some early article by Howe, one can trace his clear understanding, even then, of metallurgical matters upon which most metallurgists are still hazy in spite of the new evidence at their disposal.

Could Howe be reincarnated today, he could discuss any technical paper at any metallurgical meeting and set the author straight on many an obscure point.—H. W. GILLETT.

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Typical G-E continuous copper-brazing furnace

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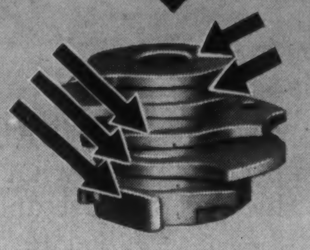
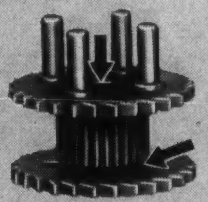
If you want to improve your products and make savings, investigate G-E electric-furnace brazing. The coupon below will bring you additional information.

Save time and money—see General Electric for everything in electric furnaces

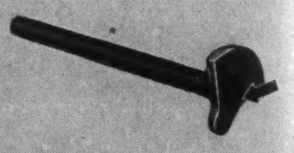
GENERAL ELECTRIC



National Cash Register Co. riveted and pinned this cam cluster (shown ⅔ actual size). Now stakes and electric-furnace brazes it. Result: increased strength, reduced weight, and longer life



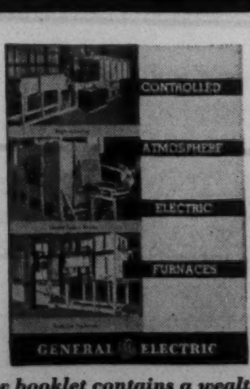
Remington-Rand, Inc. riveted and stake-pinned the hub shoulders of the gear to the ratchet, in this assembly (⅔ size). Parts now pressed together and electric-furnace brazed. Result: greater strength and durability, lower costs



Union Special Machine Co. machined this main shaft (⅛ size) from solid bar stock. Flanged end now electric-furnace brazed, saving time and money by eliminating much machine work

We ourselves use electric-furnace brazing to improve products and cut production costs. Above float (⅙ size) is one of six electric-furnace-brazed assemblies used in G-E refrigerators

SEND FOR COMPLETE INFORMATION



New booklet contains a wealth of useful information on Controlled-atmosphere Electric Furnaces

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Please send me a copy of your new bulletin, "CONTROLLED-ATMOSPHERE ELECTRIC FURNACES" (GEA-1924), which will give me more information on money-saving G-E electric-furnace brazing.

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Company..

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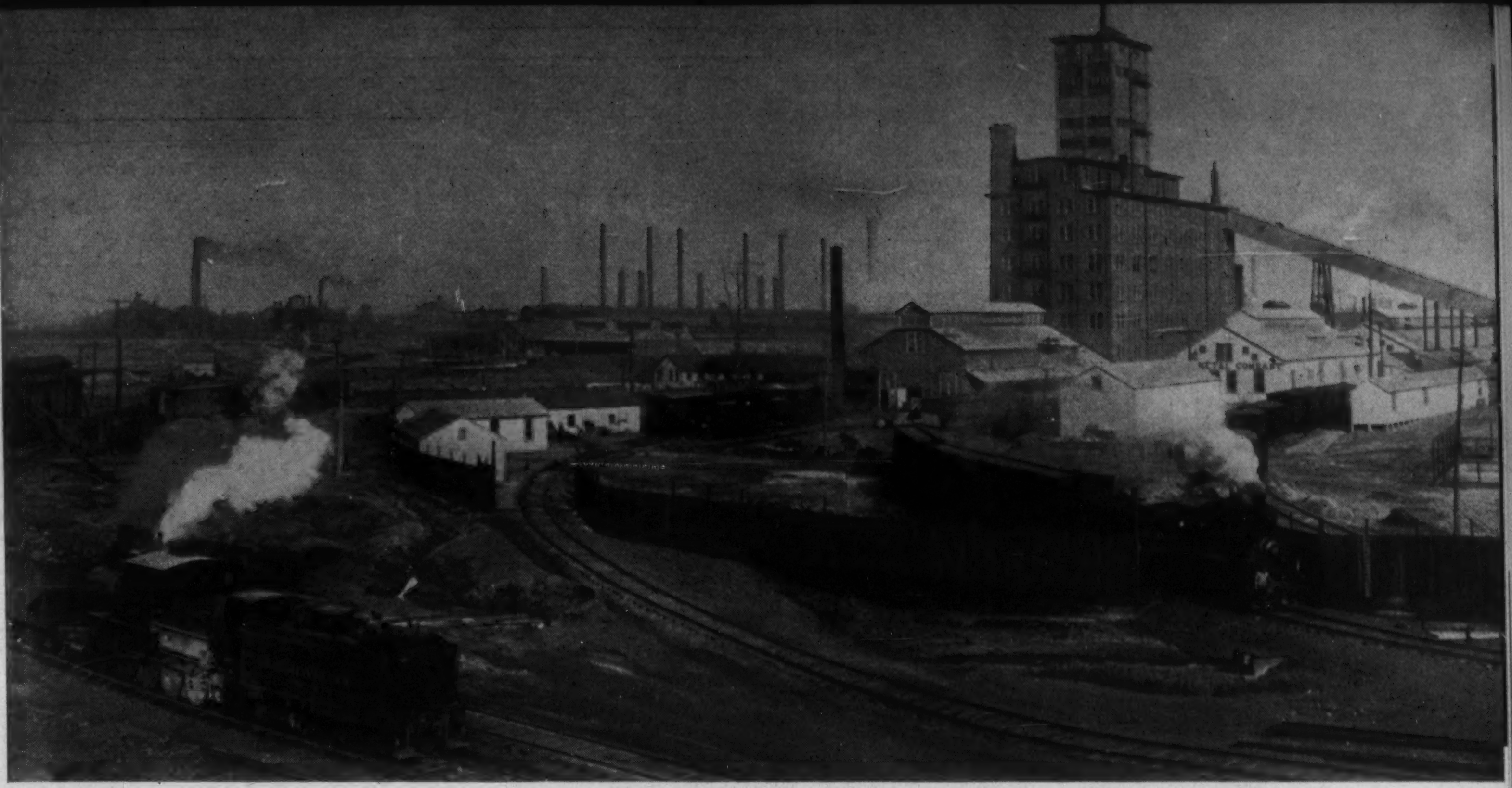

Shot Tower at the Plant of the National Lead Co., Maurer, N. J.

The Surface Tension of Molten Lead Alloys Under Oxidizing Conditions

By H. Vance White*

WITHIN RECENT MONTHS surface tension has assumed a deservedly prominent place in metallurgical literature. Lack of data and not a lack of realization of its importance was responsible for the previous meager consideration given this property of molten metals. An article[1], previously published in METALS & ALLOYS, presented an excellent correlated abstract of practically all work which had been published on this subject to that date.

Results obtained on absolutely clean liquid surfaces are of great academic interest and, in some cases, industrial conditions are such that these results are applicable. In the majority of cases the practical uses of the metals subject them to more or less oxidation and results obtained in vacuum or under reducing conditions are not applicable. In fact, they may be misleading. Apparently the effect of oxidation on the surface tension of molten metals has been neglected entirely with a single exception. The exception is the effect of temperature on the surface tension of pure tin in air[2].

Determining Surface Tension Under Oxidizing Conditions

A quick method for determining surface tension has been developed and applied for some alloys of fairly low melting points[3]. In this paper the method will be outlined very briefly.

For the above-mentioned work the apparatus was made of an iron-chromium alloy noted for its resistance to oxidation at high temperatures. Referring to Fig. 1, the parts A and B bolt together to form a reservoir (R) of such diameter that a negligible depression, due to capillarity, takes place. These parts also form three walls of a casting chamber (CC) in which a bar about 0.5 by 1.0 cm. is cast. A small V-shaped groove connects the reservoir with the casting chamber. The parts C and D bolt together with a thin metal strip between them. The width of the strip is about a millimeter less than that of the pieces C and D, which results in the formation of a groove a millimeter deep and of a width equal to the thickness of the strip. The assembled C and D bolt to assembled A and B, the wall of C and D containing the capillary groove forming the fourth wall of the casting chamber.

As the first step in a determination, the apparatus was heated to the temperature desired. The alloy under study was melted in a small crucible and the temperature adjusted to the same as that of the apparatus. The apparatus was then removed from the furnace and placed on a piece of hot asbestos board resting on a plane table. The molten metal was then literally dumped into the reservoir from which it ran down through the V-groove into the casting chamber, with the result that below a certain depth of metal the pressure was sufficient to force the metal into the narrow groove.

At less than this depth the metal did not enter the groove, as is shown in Fig. 2. The height from the top of the meniscus down to the point at which the metal entered the narrow groove was measured by placing a steel square across the top of the meniscus and measuring from this with a scale. Measurements were made to the nearest 0.025 cm. The formula $\gamma = \frac{hdgw}{2}$, gives the surface tension of the metal under the prevailing conditions. γ is the surface tension, h is the height of metal necessary to force itself into the groove of width w, g is the acceleration due to gravity, and d is the density of the metal at the test temperature.

The time required for the molten alloys to flow from the reservoir, through the V-groove into the casting chamber has varied from two to not over five seconds depending on the viscosity of the alloys. The alloys remain completely molten for a full minute or more after all flow has apparently ceased. These facts are believed to eliminate such factors as specific heats, heat conductivities, latent heat of fusion, and viscosity. The mass of the mold is so adjusted that freezing starts on the surface of the meniscus in the reservoir at the side away from the casting chamber (see Fig. 2). This is soon followed by the freezing of the metal in the capillary groove.

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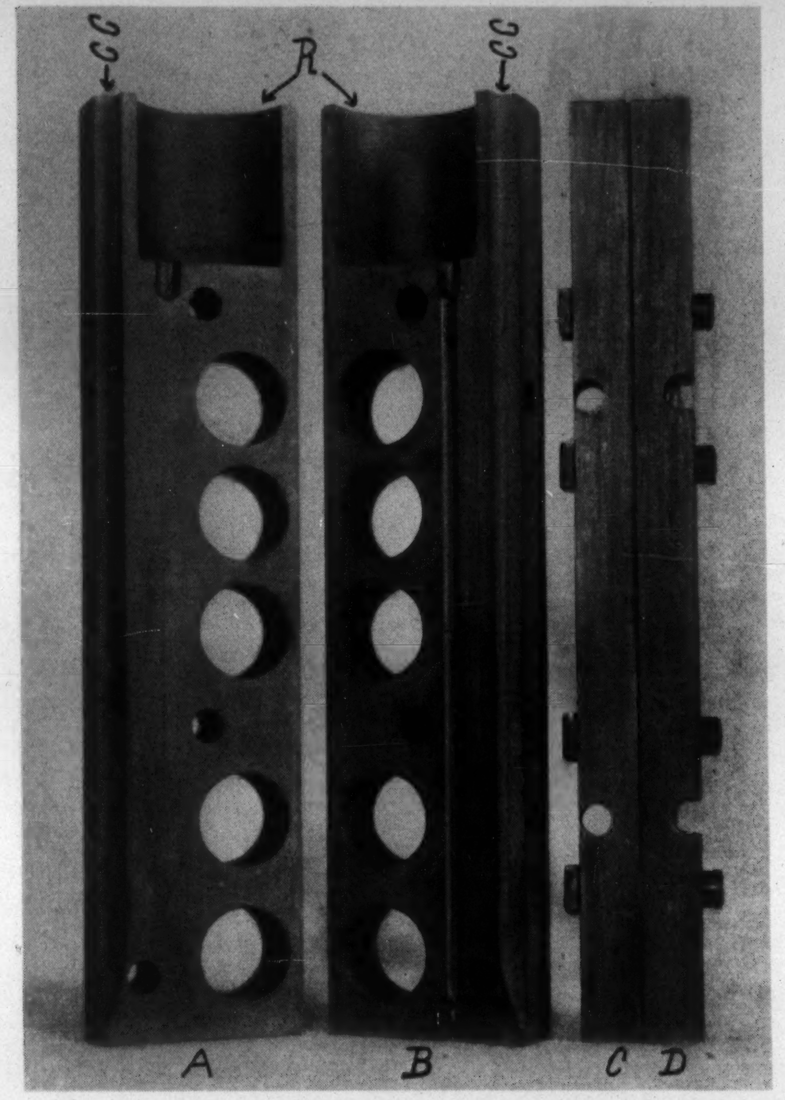

Fig. 1. The Apparatus Unassembled.

Thus the two important points are fixed soon after freezing starts and solidification shrinkage is largely eliminated. When applying the method at temperatures well above the melting point of the alloy, liquid shrinkage introduces an error and it is possible that part, or all, of any effect due purely to temperature may be lost. Any indirect effect of temperature, through the nature of the oxide film formed at the higher temperature, will not be lost, for obviously the cooling will not reduce the amount of oxide.

The contact angle is not neglected because the meniscus between the two edges of the groove can hold the pressure against it until the contact angle becomes 180 deg. That is, the cosine of the contact angle, at the point where the metal enters the groove, is—1 and may be omitted from the equation. The minus sign simply indicates that the adhesion and cohesion relations are such that the force resulting from surface tension opposes the liquid entering the capillary opening. For a detailed discussion of the design of this apparatus and the errors and applications of this method, the reader is referred to the original publication[3].

The method is not to be confused with some of the more elaborate and more precise methods for determining surface tension of molten metals under non-oxidizing conditions. The formula would require a correction factor for exact work. Everything considered, the results by this method are probably a little low. They are, however, comparative. The conditions of oxidation are those of an actual casting operation and there can be little doubt about approximating those practical conditions which affect surface tension. With many alloys the results will duplicate within 2 per cent of an average when a series of determinations is made. Some alloys will not give results in such close agreement.

Effect of Oxidation on Surface Tension

From the meager results we have, it appears that, as a rule, the addition of a small amount of a metal to a large amount of another metal or alloy does not appreciably change the surface tension of the predominating metal when oxidation is absent. In most cases the resulting surface tension is roughly a weighted average of the surface tensions of the two metals. When oxidation enters, this is no longer true. Possibly it would appear that the same relations should exist between the surface tensions of a group of alloys whether under oxidizing conditions or under reducing or neutral conditions. This may be so in the majority of cases but in some instances at least it is not true. In recent metallurgical literature are several instances of deductions drawn for oxidizing conditions from data under non-oxidizing conditions.

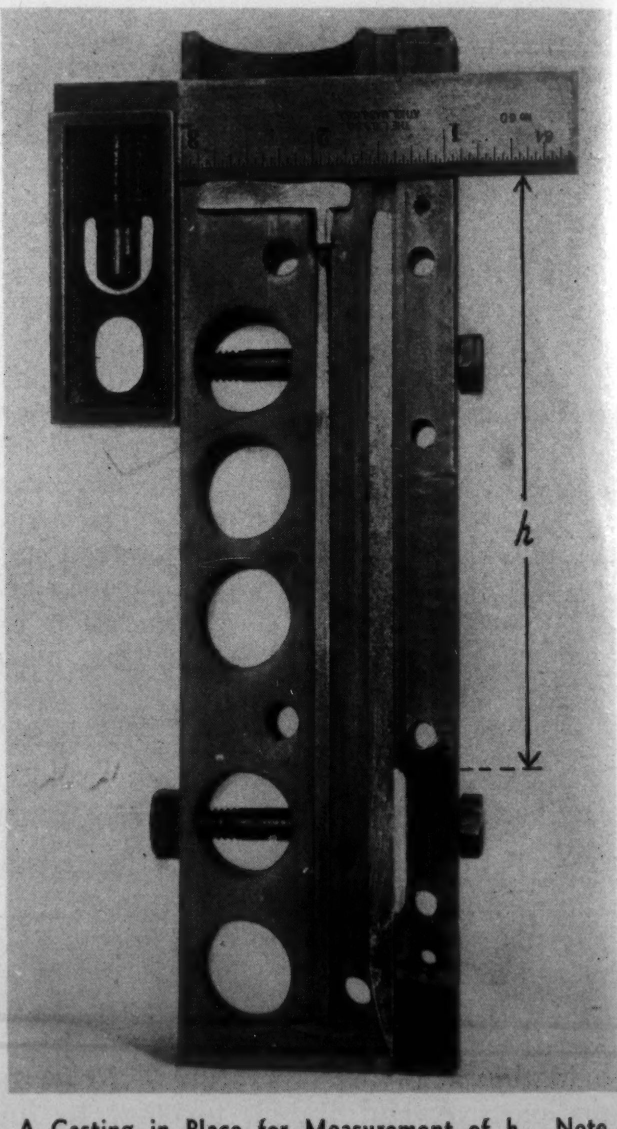

Fig. 2. A Casting in Place for Measurement of h. Note that the meniscus in the reservoir is higher on the left side. For purposes of illustration the capillary groove used was deeper than usual

Table I gives some results obtained on linotype alloy using a modification of Cantor's method[4], in which the metal is forced upward through a capillary tip. These results show that oxidation actually lowers the surface tension of some commercial linotype alloys. The lowering of surface tension was entirely unexpected. Yet, when even a very small amount of zinc is present in the alloy, the surface tension is greatly increased. It should be noted that the zinc does not increase the surface tension under reducing conditions. The values given are not to be taken as absolute values for the surface tension of these alloys under oxidizing conditions, rather, only as values for the specific conditions existing during these determinations. The metal was exposed to the respective atmospheres for a period of 45 seconds to one minute.

Table I.—Surface Tension Determinations by Cantor's Method in Reducing and in Oxidizing Atmospheres

Alloy	Atmosphere *	No. Obs.	Surface Tension, dynes per cm.
Linotype No. 1	Reducing	7	454
Linotype No. 1 plus 0.2% of Zn	Reducing	10	455
Linotype No. 1 plus 0.2% of Zn	Reducing plus 10% air	5	761
Linotype No. 1 plus 0.2% of Zn	Reducing plus 50% air	5	1198
Linotype No. 2	Reducing	9	445
Linotype No. 2	Reducing	8	446
Linotype No. 2	Air	6	428
Linotype No. 3	Reducing	6	433
Linotype No. 3	Air	5	407
Linotype No. 3	Reducing	7	433
Linotype No. 3	Air	6	395

All determinations may be considered as at 260 deg. C.
Linotype No. 1—Sb 12.0%; Sn 4.27%; As .071%; Cu .02%; remainder, lead.
No. 2—Sb 11.8%; Sn 4.18%; As .045%; Cu .00%; remainder, lead.
No. 3—Commercial linotype metal, composition unknown.

* Reducing atmosphere was Pyrofax gas bubbled through $KMnO_4$ solution, concentrated H_2SO_4, and passed through a P_2O_5 tube.

Using the groove-pressure method described above, the time of exposure was only two to five seconds, the metal being exposed to the full oxidizing power of air. Table II presents some results by this method compared with results on the same alloy by Cantor's method. Comparing results under reducing conditions by Cantor's method with results under oxidizing conditions by the groove-pressure method, the effect of oxidation on the surface tension of monotype metal seems to be a slight increase. When 0.2 per cent of zinc was added to this alloy the increase in surface tension due to oxidation became greater. It is clearly shown that the time of exposure has a decided influence upon the increase of the surface tension of these alloys containing zinc.

Table II.—Surface Tension Determinations by Cantor's Method and by the Groove-Pressure Method

Alloy	Method used	Atmosphere	Temp., deg. C.	Surface Tension, dynes per cm.
Monotype	Cantor's	Reducing	300	443
Monotype	Cantor's	Reducing	302	444
Monotype	Cantor's	Reducing	292	440
Monotype	Groove-Pressure	Air	273	465
Monotype	Groove-Pressure	Air	273	452
Monotype	Groove-Pressure	Air	273	461
Monotype	Groove-Pressure	Air	273	457
Monotype plus 0.2% Zn	Groove-Pressure	Air	280	606
Monotype plus 0.2% Zn	Groove-Pressure	Air	280	610
Monotype plus 0.2% Zn	Groove-Pressure	Air	280	557
Monotype plus 0.2% Zn	Groove-Pressure	Air	280	625

Composition of alloy—Sb 16.53%; Sn 7.0%; Cu .00%; remainder, lead.

The effect of several other impurities on the surface tension of monotype metal was also determined, the results of which investigation are summarized in Table III. The usual effect seems to be a slight increase in surface tension. However, sodium caused a marked decrease in the value of this property. The author believes that this large increase in surface tension is largely responsible for the very harmful effect of zinc in type metals. As little as 0.1 per cent of zinc is decidedly noticeable in the clearness of type cast from the alloy and 0.2 per cent is very harmful.

Zinc is the only one of these eight impurities, in the quantities present, which will seriously interfere with the "fine-detail-reproducing-ability" of the lead-tin-antimony type-metal alloys. It is not probable that this amount of zinc would appreciably change any of the thermal properties of these alloys. It may increase the viscosity, but Portevin and Bastein[5] established that viscosity is unimportant in determining the running qualities of a molten metal.

A Practical Application of Same to the Lead Alloys.

Table III.—Summary of the Effect of Impurities on the Surface Tension of Monotype Metal under Oxidizing Conditions as Determined by the Groove-Pressure Method

Impurity	Per Cent of Impurity	Increase in Surface Tension, Per Cent
Zinc	0.20	28.9
Arsenic	0.15	2.6
Arsenic	0.30	4.1
Bismuth	1.00	1.3
Bismuth	4.00	3.4
Cadmium	1.00	3.9
Magnesium	0.10	3.9
Sodium	0.05	—29.5
Potassium	0.05	2.4
Iron	0.08	4.5

All determinations between 273 and 280 deg. C.
Composition of alloy to which impurities were added—Sb. 16.53%; Sn. 7.0%; Cu. .00%; remainder lead.

From our present knowledge there is no explanation for the harmful effect of zinc in type metals through the properties which we believe to be important in castability as the term is ordinarily used. Surface tension will oppose a molten metal entering a mold or any section of a mold. Only when the metal must pass through an opening of very small size, however, will the force opposing the flow become of sufficient magnitude to have any practical significance. In the author's opinion the ability of a metal or alloy to reproduce the very fine detail of a mold is dependent upon surface tension and those factors which affect runability. The old idea that type metals expanded on freezing, thus forcing the metal into all tiny crevices and corners of the matrices has been found incorrect. According to Matuyama[6] there is no expansion at any time during the freezing of these alloys.

Surface Tension in Shot Manufacture

In Table IV is presented the effect of sodium and arsenic on the surface tension of hearth-refined lead and lead-rich lead-antimony alloys. The effect of arsenic is a slight lowering of the surface tension of both the lead and the alloy of lead and antimony. This fact is in direct opposition to the old idea that the presence of arsenic makes the manufacture of drop shot possible by increasing the surface tension of lead, causing it to form into perfect spheres while falling free through an air column. Furthermore, while the sodium caused a decrease of about 25 per cent in the surface tension of the lead or lead alloys, it also caused them to form into spheres when they were free to do so. According to laboratory tests the sodium alloy is equally as effective as the arsenic alloy for making shot. Whether the sodium alloy will prove satisfactory for shot remains to be seen, as many other factors enter into both the use and the manufacture of the shot. It appears that there may be several advantages so far as the manufacture is concerned.

G. Tamman and K. L. Dreyer[7] were the first to suspect that the formation of shot was not due to an increase in the surface tension of the alloy caused by the presence of arsenic. They worked on the theory that the oxides formed on the surface of the drops existed as very thin fluid films due to the fluxing action of the As_2O_3 formed. They did not make any surface tension determinations. They assumed no increase in surface tension because the addition of small amounts of antimony and bismuth was known to cause no increase (actually a lowering of about 0.5 per cent for 1 per cent of antimony[2] and 0.4 per cent for 2 per cent bismuth[8]) in the surface tension of lead. It appeared reasonable that the addition of a fraction of 1 per cent of arsenic would have little effect. The results on which they based their assumption were obtained under non-oxidizing conditions, and while this assumption of no increase in surface tension was practically correct, it was not justified.

Effect of Variation in Temperature on Surface Tension

Matuyama[2] determined the effect of variations in temperature on the surface tension of pure tin in air. He found that an increase in temperature caused a lowering of the surface tension of the tin. This is known to be the usual effect on metals and alloys under non-oxidizing conditions. Within the ranges of temperatures studied, the surface tension-temperature curves are straight and of practically the same slope. Matuyama found the slope of the curve for tin to be about the same in air as in vacuum, the actual values in air being higher than those in vacuum.

Table IV.—Surface Tension of Some Lead Alloys by the Groove-Pressure Method

Alloy			T., deg. C.	h	Surface Tension dynes per cm.*
Lead	....	....	338	4.65	466
Lead	....	....	343	4.65	
Lead	....	....	339	4.60	
Lead	....	....	341	4.80	
Lead	0.16% As.	....	340	4.30	427
Lead	0.16% As.	....	340	4.30	
Lead	0.16% As.	....	343	4.30	
Lead	0.54% As.	....	338	4.45	434
Lead	0.54% As.	....	340	4.35	
Lead	0.54% As.	....	339	4.40	
Lead	0.30% As.	3.0% Sb.	350	4.45	438
Lead	0.30% As.	3.0% Sb.	341	4.45	
Lead	0.30% As.	3.0% Sb.	343	4.40	
Lead	0.20% Na.	1.4% Sb.	350	3.55	347
Lead	0.20% Na.	1.4% Sb.	347	3.50	
Lead	0.20% Na.	1.4% Sb.	348	3.50	

* Average of determinations indicated.

Working with commercial linotype metals the author found that an increase in temperature resulted in an increase in the surface tension under oxidizing conditions. This has been confirmed for several samples of lead and lead-rich alloys, all of commercial purity. Only the results on linotype metal will be given at present. They are presented in Table V. Special attention should be called to the fact that these alloys were of commercial purity, and that the groove-pressure method may show only changes primarily due to increased oxidation, as previously explained.

Chemical Relation of Elements No Guide to Effect on Surface Tension

Perhaps it would seem logical to expect elements which are closely related chemically to have very much the same effect on the surface tension of a molten metal. This may be true, provided due allowance is made for differences in temperature. In comparing surface tensions at the same temperatures, however, it does not hold.

Table V.—Effect of Temperature on the Surface Tension of Linotype Metal under Oxidizing Conditions as Determined by the Groove-Pressure Method

Alloy	Temp., deg. C.	Surface Tension dynes per cm.
Linotype No. 1........................	248	453
Linotype No. 1........................	263	484
Linotype No. 1........................	282	488
Linotype No. 1........................	340	494
Linotype No. 2........................	253	478
Linotype No. 2........................	252	478
Linotype No. 2........................	325	506

Commercial alloys, compositions unknown.

Two striking examples may be taken from the tables presented. Sodium causes a marked decrease in the surface tension of monotype metal; yet potassium, which in properties is almost identical to sodium, causes a very minor change in surface tension at the same temperature. Zinc and cadmium are closely related chemically. When these metals are allowed to oxidize they form stringy, tough oxides which are similar from a physical standpoint. A mere trace of zinc will cause a large increase in the surface tension of monotype metal while cadmium, even when present in considerable amounts, causes very little change.

The controlling factor may be the nature of the oxide films formed, whether liquid or solid—if liquid, whether very fluid or viscous, and if solid, whether a finely divided powder or a more or less tenacious crust. Possibly surface tension-temperature curves will show sudden breaks at temperatures corresponding to temperatures of slag formation or at melting points of the slags formed.

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Rapid Etching of Cementite in Steels

By H. S. van Klooster and Wm. J. Schaefer*

UP TO THE PRESENT time, rapid cementitic etching at room temperature with reagents that are readily available has been impossible. The universal method is to immerse the sample for 5 to 10 min. in a *boiling* solution of sodium picrate in an excess of sodium hydroxide as recommended by Kourbatoff and LeChatelier. In 1924, Pilling[1] found that a solution of nitric acid and nitrobenzene in anhydrous methyl alcohol etches cementite in silicon and manganese steels in 20 sec. at room temperature. The necessity of fuming nitric acid and anhydrous methyl alcohol, two uncommon laboratory reagents, greatly affects the general use of the solution. Furthermore, the solution deteriorates rapidly in use by contamination with water.

Some Work by a Russian

In 1930 Svechnikov published an article (in Russian) on new etching reagents, an abstract of which appeared two years later[2], stating that an alkaline solution of pyrogallol etches cementite in several hours at room temperature. The work of Svechnikov suggested to the authors that it might be advantageous to investigate some acids and their alkali salts in neutral or alkaline solution for their etching effect on ferrous alloys.

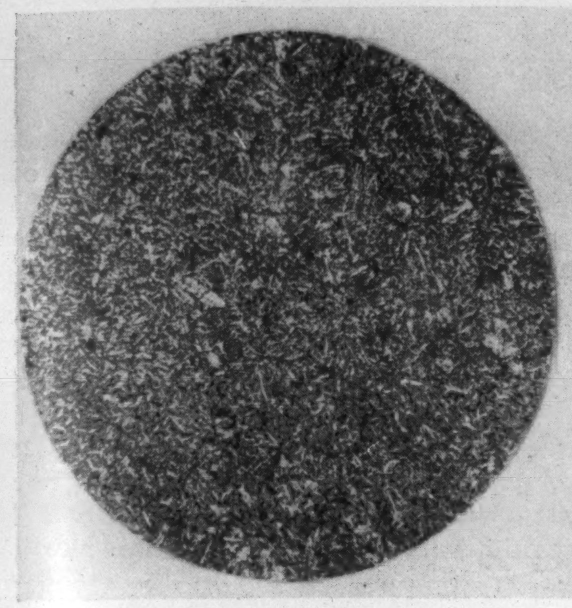

Fig. 1. Martensite. Etched with 25% alc.H_3PO_4. 100 diameters

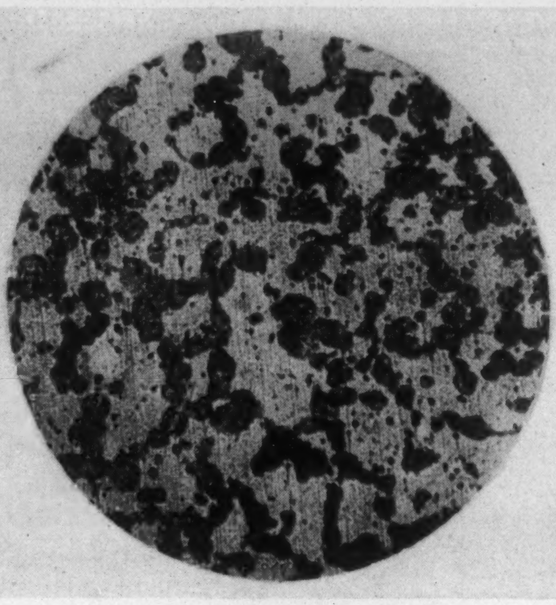

Fig. 2. Martensite and Troostite. Etched with 25% alc.H_3PO_4 for 1 min. 100 diameters

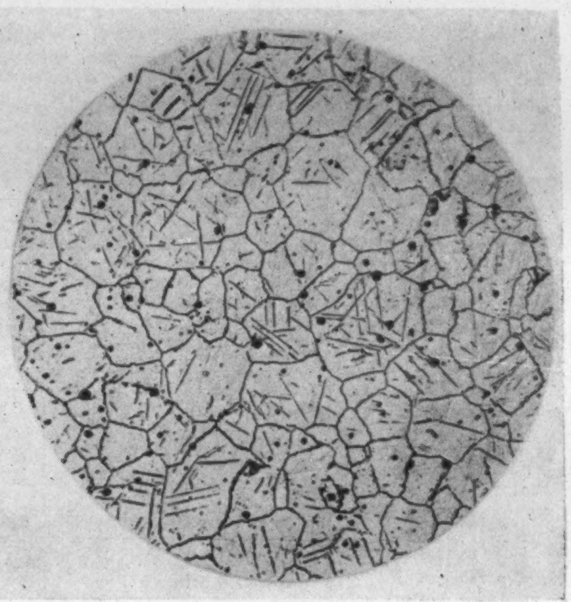

Fig. 4. 1.2% C Steel. Etched with 30% NaOH plus pyrogallol for 8 min. 100 diameters

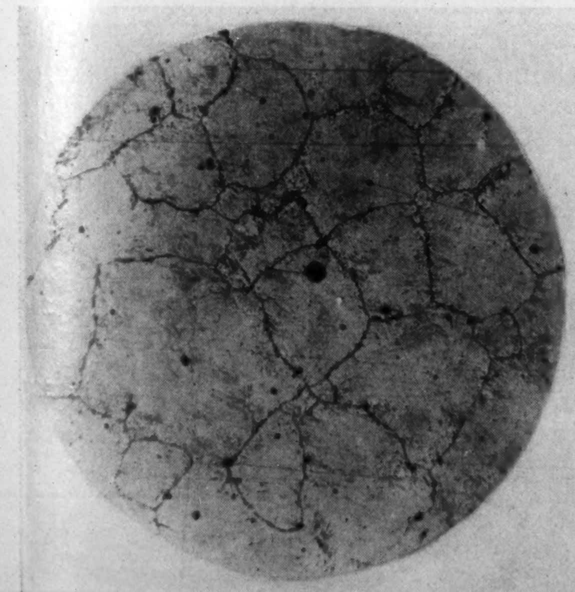

Fig. 5. 1.2% C Steel, Heated to 1100 deg. and Slowly Cooled. Etched with 30% NaOH pyrogallol, 10 min.

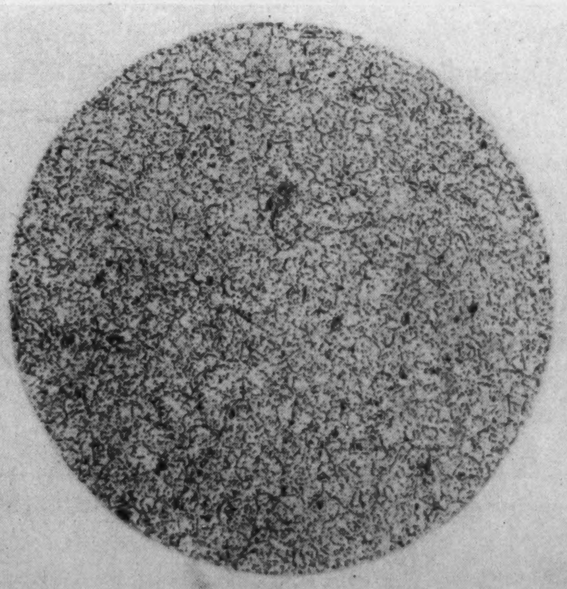

Fig. 6. 1.1% C Steel, Spheroidized. Etched with 30% NaOH plus pyrogallol for 10 min. 100 diameters

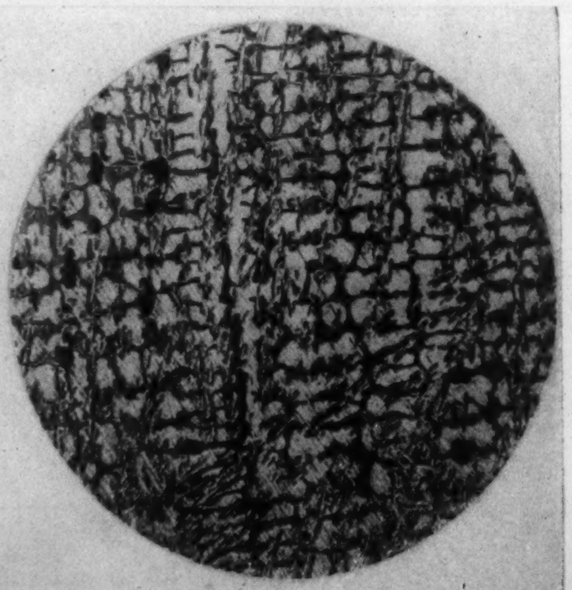

Fig. 7. White Cast Iron. Etched with 30% NaOH plus pyrogallol for 45 min. 100 diameters

Although a number of solutions were found that bring out the pearlitic structure, none of those used were superior to those ordinarily employed. Martensite and troostite were readily etched with a 25 per cent alcoholic solution of phosphoric acid (Figs. 1 and 2). The chief objective, however, remained to find a suitable substitute for the troublesome boiling alkaline sodium picrate. Quite recently Glazunov and Petak[3] have tried to substitute meta and para-nitrophenol for the picric acid in Kourbatoff's reagent, but here again it proved to be necessary to heat the alkaline solution to bring out the structure.

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In carrying out a systematic test of the etching effect of different reagents, solutions of sodium hydroxide in concentrations of 10, 20, 35 and 50 per cent were tried. All of these failed to blacken cementite in 30 min. at room temperature. These results were in agreement with those of Groesbeck[4]. Prolonged boiling, however, darkens the cementite. Neutral solutions of sodium picrate and sodium gallate, likewise 20 per cent alcoholic solutions of pyrogallol and gallic acid were ineffective.

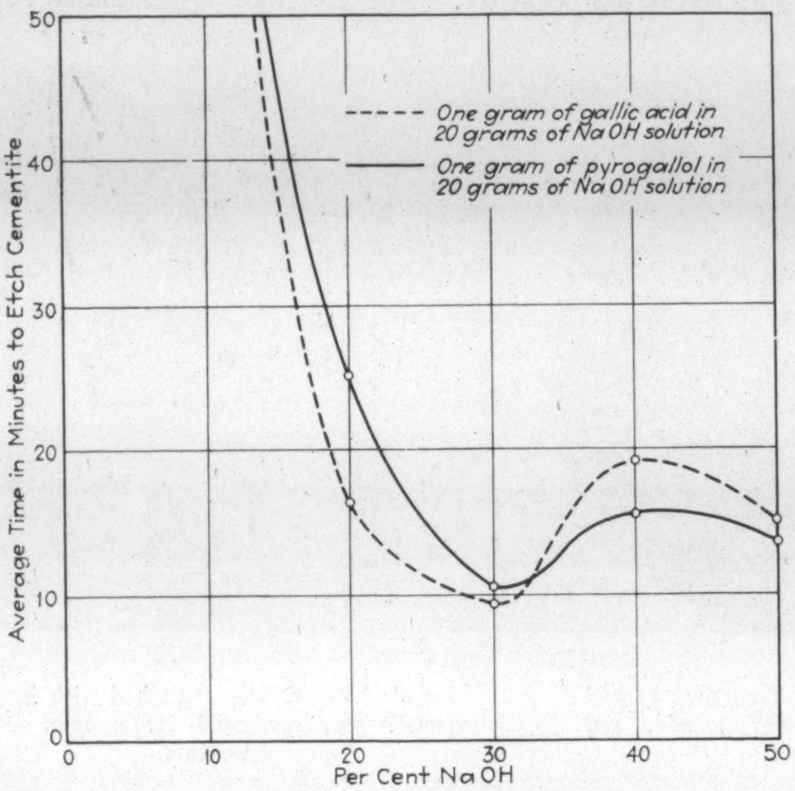

Fig. 3. Comparison of NaOH-pyrogallol Solution with Svechnikov's in Darkening Cementite

Varying the Proportions of Pyrogallol and Alkali

An attempt was then made to obtain results by using varying proportions of both pyrogallol and alkali. Svechnikov's reagent consists of one part of a 25 per cent aqueous solution of pyrogallol and two parts of 35 per cent sodium hydroxide, which corresponds to 8 per cent pyrogallol and 23 per cent sodium hydroxide. The authors proceeded by dissolving one gram of pyrogallol in 20 grams of a 10, 20, 30, 40 and 50 per cent solution of sodium hydroxide. A similar set of solutions was made up by dissolving one gram of gallic acid in 20 grams of the same alkali solutions. The *average* time to produce darkening of the cementite was noted.

The results are recorded in the graphs of Fig. 3, which shows that a solution of one gram of pyrogallol (or of gallic acid) in 20 grams of 30 per cent aqueous sodium hydroxide will darken cementite in from 8 to 15 min. at room temperature, as contrasted with several hours for the solution of Svechnikov. The results obtained with the NaOH-pyrogallol solution on hypereutectoid steels and cast iron are illustrated in Figs. 4, 5, 6 and 7. It should be noted that the etching of the large masses of cementite in cast iron requires considerably more time than that of the lamellar and globular particles of cementite in steels.

Liebig's Solution for Steels

The authors then tried Liebig's alkaline pyrogallol solution used in gas analysis for the adsorption of oxygen. This solution, made by first dissolving 5 grams of pyrogallol in 15 cc of water and introducing the resulting solution into a solution of 120 grams of potassium hydroxide in 80 cc of water, proved to be most successful in etching cementite in steels. The cementite will darken at room temperature in from 7 to 10 min.

More rapid results are had at slightly higher temperatures, conveniently obtained by preheating the specimen for half a minute at a distance of about 2 in. above the tip of a small non-luminous flame of a Bunsen burner. On applying a drop of the etching reagent to the warm sample by means of a glass rod, the cementite will be etched in about 90 sec. Care should be taken that the sample is not hotter than about 50 to 60 deg. C., so that it can be readily picked up by hand since the alkaline pyrogallol readily decomposes on heating and in that case no cementite etch is obtained.

Cementite in Cast Irons

Cementite in cast irons will not show up even on the preheated specimen until after 15 to 20 min. In using the alkaline pyrogallol there is no danger of over-etching as prolonged exposure merely brings out some of the fine structure of the pearlite. The solution, if kept in small, well stoppered, amber-colored bottles, will keep for several weeks.

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Nitriding Characteristics of Cr-Mo-V Steels

An Aluminum-Free Series of Nitriding Steels

By Jerome Strauss[*] and W. E. Mahin[†]

THE NITRIDING PROCESS, when applied to steels especially developed for the purpose, provides a means of obtaining on finished parts a surface hardness and resistance to wear previously unattainable. Perhaps equally important, however, are the collective advantages over the older method of surface hardening by carburization and subsequent heat treatment, namely that articles can be finished accurately to size and then hardened without effecting indeterminate growth, distortion, or undesirable surface changes so characteristic of ordinary heat treatment. Moreover, the nitrided surface possesses resistance to certain types of corrosion as well as retention of hardness upon heating to 1000 deg. F. or higher, both of which properties are lacking in case carburized steels.

That the possibilities of nitriding have been of commercial as well as academic interest is attested by the numerous investigations reported during the past seven years in the literature of Germany, France, Great Britain, the United States, and other countries. Much of this work has dealt with alterations in the process itself to obtain the desired result in a shorter time, or to improve the quality of the product. As usually practiced today, the procedure consists essentially in:

> (1) Quenching the steel from a temperature of 1600 to 1800 deg. F., (2) tempering at 950 to 1250 deg. F., (3) finishing to final size, and (4) treating in an atmosphere of ammonia for about 5 to about 50 hr., depending upon the depth of case desired, followed by cooling in the container while the ammonia flow is maintained. As a precaution against distortion, step (3) is sometimes split into: (a) rough machining, (b) tempering to relieve stresses induced by (a), and (c) final machining or grinding to size.

Although it has long been known that steels as well as other metals absorb nitrogen upon heating in ammonia, important developments appeared only after Fry's discovery that certain alloying additions to steel were necessary in order to produce suitable case-hardening. Principal among these elements was aluminum. The earliest nitriding steels contained between 1 and 2 per cent aluminum together with chromium in about an equal amount, and even today the steel most commonly used is one containing approximately the same original proportions of aluminum and chromium, together with a small amount of molybdenum. The approximate composition of this steel and of some others that have been advocated are listed in Table I.

In steel No. 3 of Table I, the chromium has been dispensed with in favor of an increased molybdenum content and nitriding characteristics are approximately the same as in steel No. 1. Steel No. 4, in which aluminum is replaced by relatively high vanadium, nitrides (usually at a lower temperature) to produce a hardened layer of less hardness but greater depth than that of steel No. 1. In steels Nos. 5, 6, and 7, a much higher chromium content replaces the usual aluminum, and this together with appreciable quantities of molybdenum, silicon, vanadium, or tungsten, places these steels in the highly-alloyed class. Steel No. 5 when nitrided develops a maximum hardness in excess of that in steel No. 1, but in a very shallow layer. Steels Nos. 6 and 7 are designed for applications requiring exceedingly high core strength.

Table I.—Chemical Composition of Nitriding Steels (Approximate Per Cent)

No.	C	Mn	Si	Al	Cr	Mo	V	W
1	0.25	0.50	0.25	1.20	1.20	0.20	...	...
2	0.35	0.50	0.25	1.20	1.20	0.20	...	...
3	0.25	0.50	0.25	1.25	...	0.80	...	...
4	0.30	0.50	0.25	...	1.50	...	0.60	...
5	0.55	0.30	1.50	...	8.00	0.70	...	...
6	1.50	0.35	0.35	...	12.00	1.00	1.00	...
7	1.50	0.35	0.35	...	12.00	...	...	0.80

Aside from the steels just described, it has been reported that the chromium-vanadium constructional steel S.A.E. 6125 will nitride to give a hard layer of unusual depth and a hardness corresponding to that of case-carburized steels. Further, data are available indicating that high-speed and certain other highly-alloyed tool steels, as well as austenitic iron-chromium-nickel alloys containing aluminum, may be effectively surface-hardened by nitriding. Various efforts have been directed toward enhancing the core hardness of the aluminum-chromium-molybdenum steels by making such alloy additions as 2 to 4 per cent of nickel, or increased molybdenum together with tungsten and

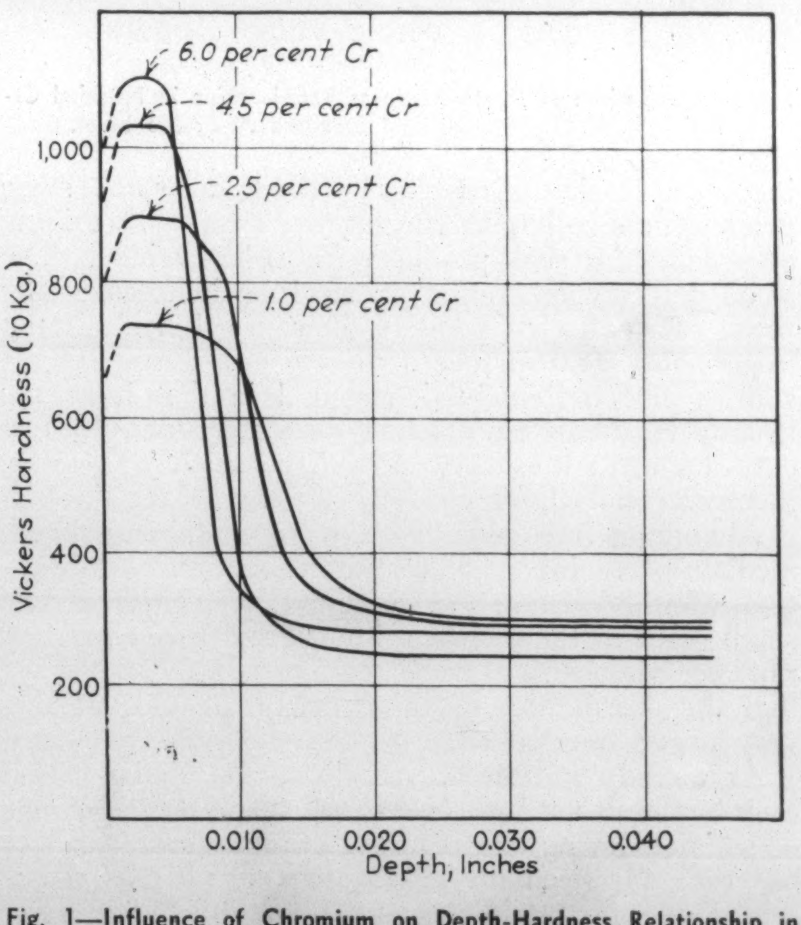

Fig. 1—Influence of Chromium on Depth-Hardness Relationship in Nitrided Cr-V Steels.

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[*] Chief Research Engineer, Vanadium Corporation of America.

[†] Research Department, Vanadium Corporation of America.

vanadium, the latter additions also being accompanied by an increased carbon content.

As an alloying element in steel, aluminum was of little importance prior to the development of the nitriding process. In fact its use today for this purpose entails serious disadvantages from the standpoint of steel manufacture. The so-called "alligator skin," likely to be found at the surface of aluminum steel ingots, necessitates rough machining at some stage prior to final rolling or forging if excessive machining allowances for such products are to be avoided. The same defect when found on steel castings, especially those of small size, renders their use difficult if not impossible. Sub-surface occurrence of alumina is, of course, also extremely detrimental in that it results in imperfections on machined surfaces and in low core ductility; it is very difficult completely to avoid in commercial aluminum-rich steels.

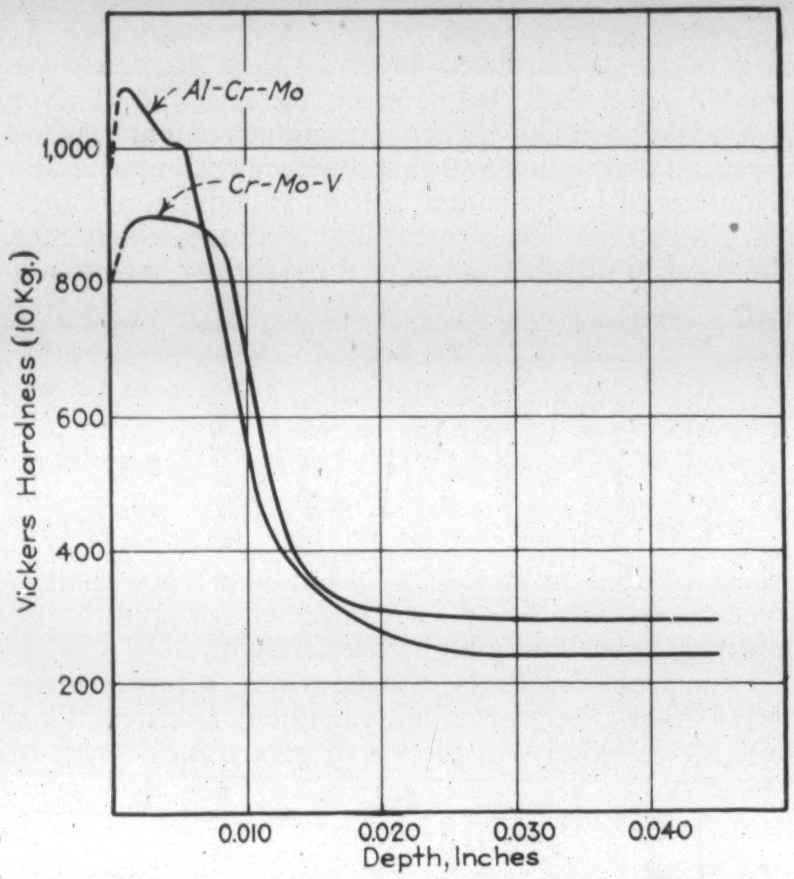

Fig. 2—Comparison of Depth-Hardness Relationships in Nitrided Cr-Mo-V Steel (2.65% Cr) and Standard Al-Cr-Mo Steel.

Aluminum-free nitriding steels, containing intermediate percentages of chromium together with additions of molybdenum and vanadium, have found a very small place in the nitriding literature. From the few random compositions reported upon, indications are that the possibilities of this type of steel have been very largely overlooked.

As already indicated, vanadium and molybdenum each has been used in commercial nitriding steels, but no satisfactory application of both in the same product has thus far been made. Moreover, no *widely accepted* steel for nitriding has not contained aluminum. The data herein recorded, accumulated in studies of nitrided steels during the last five years, disclose that aluminum-free steels possessing the desired characteristics for constructional use and comparable in their nitriding qualities with the aluminum steels, may be made by alloying with chromium, molybdenum, and vanadium, provided the proper proportions are selected.

Fig. 1 illustrates the effect of chromium content upon the depth-hardness relationships of some nitrided chromium-vanadium steels (all but one also containing molybdenum) whose compositions are shown in Table II. In Fig. 2 the depth-hardness characteristics of the steel containing 2.65 per cent chromium (No. 3A) are compared with those of an aluminum-chromium-molybdenum steel (No. 1A) of the common nitriding type.

In these tests as well as in all that follow, nitriding was carried out in a glass lined tube furnace at 950 deg. F. for 45 hr. at temperature, with ammonia flow carefully maintained at a constant value and temperature accurately controlled. (At 950 deg. F., per cent dissociation of NH_3

$$\left[\gamma = \frac{\frac{a}{2}}{(100 - a) + \frac{a}{2}} \times 100\right]$$

was 16 to 20, where a = volume of $N_2 + H_2$ in 100 cc. of exit gases.) Nitrided specimens were the standard two-notch square Izod bars, notched prior to nitriding. These were machined from ⅝-in. square bars after oil quenching from 1650 deg. F. and tempering at 1200 deg. F. for 2 hr. (except that steel No. 2A was tempered at 1050 deg. F.)

Table II.—Chemical Analyses of Experimental Steels

Steel No.	C	Mn	Si	Al	Cr	Mo	V
1A	0.26	0.45	0.10	1.07	1.21	0.22	...
2A	0.25	0.62	0.19	...	1.07	...	0.15
3A	0.14	0.44	0.24	...	2.65	0.56	0.27
4A	0.14	0.69	0.32	...	4.47	0.54	0.20
5A	0.18	0.60	0.20	...	5.70	0.53	0.18

The curves indicate that chromium-molybdenum-vanadium steels, containing chromium between 1 and 6 per cent, constitute a series of nitrogen-hardening steels in which maximum case hardness increases and depth of case decreases with rise in chromium content. The steel containing 1 per cent chromium (here exemplified by the S. A. E. 6100 series type without molybdenum) develops a hardness of the order of that in carburized steels together with a case depth considerably greater than usually is obtained in nitrid-

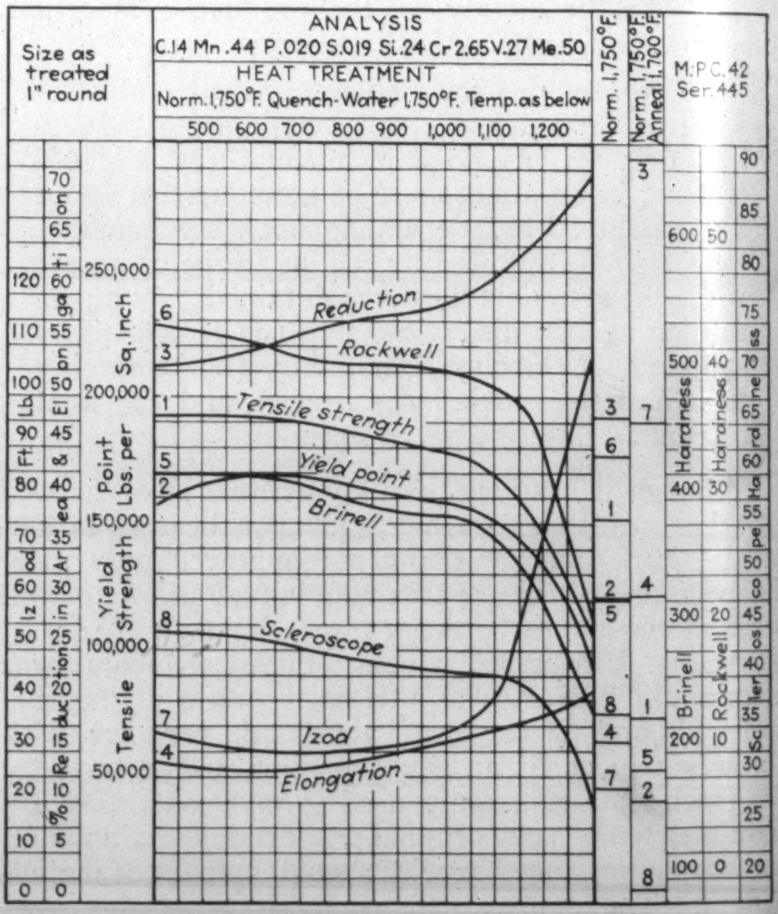

Fig. 3—Results of Tension, Impact and Hardness Tests on Cr-Mo-V Steel (2.65% Cr).

ing steels. The steel containing 6 per cent chromium nitrides to yield a hardness higher than ordinarily obtained in the aluminum steels but at some sacrifice of depth. The steel containing 2.65 per cent chromium develops a file-hard case deeper although somewhat softer than that of the aluminum steel (Fig. 2).

Among other factors to be considered in the selection of a steel for nitriding are ductility of the case, and strength or hardness, together with toughness, of the core. In the early exploitation of the nitriding process it was soon discovered that spalling or cracking of the case frequently resulted from heavy surface loads, particularly when rapidly applied, the reason being that the case itself was extremely brittle due to lack of proper heat treatment or failure to eliminate decarburization prior to nitriding. However, aside from defects originating in faulty technique, if comparison is made with carburized steels, it is obvious that the nitrided product may suffer from certain disadvantages:

(1) Somewhat lower ductility of the surface layer due to much higher hardness.

(2) Thinner hard layer than in those carburized parts designed to resist heavy loads.

(3) For equal alloying effects, lower core hardness due to the higher tempering temperature enforced by that required for nitriding.

There is then the danger and, as experience has taught, the fact that a nitrided steel may have a core hardness too low to lend suitable support to the thin hard case so that, under concentrated surface loads, the case could deflect beyond its ductility limit with consequent cracking or spalling.

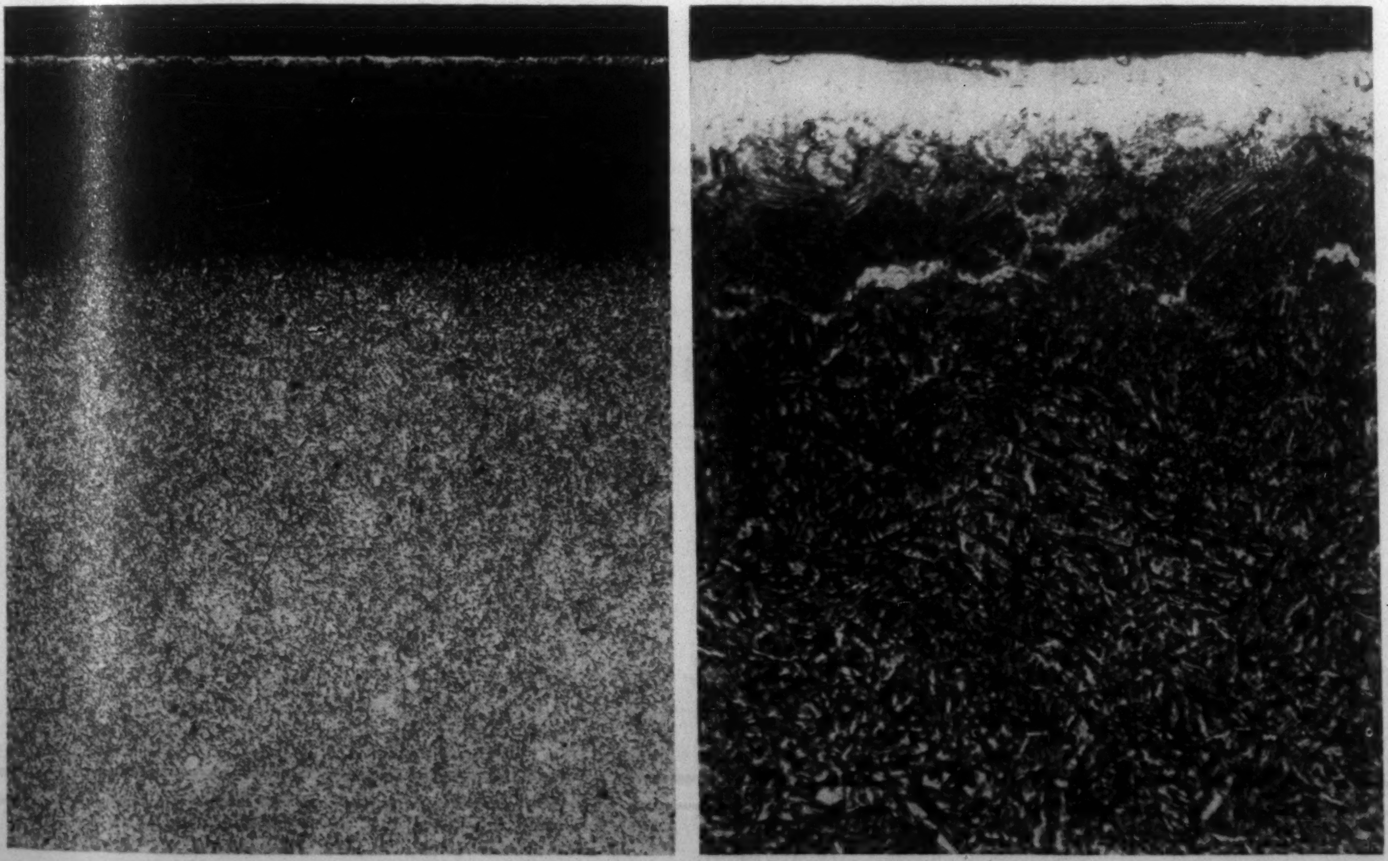

Fig. 4a and b—Microstructure of Nitrided Cr-V Steel, (6.0% Cr). Left (4b). Magnification, 100 diameters.

Right (4a). Magnification, 750 diameters.

The words "ductility" and "toughness" applied to the nitrided case have in the past been used interchangeably, which alone is contrary to sound metallurgical judgment. But perhaps even worse, there has been on the part of some authors a failure to acknowledge the dependency of case ductility measurements, where heavy surface loads are involved, upon core hardness. One valid means of evaluating relative case ductility is by microscopic observation of the Vickers diamond indentations *when light loads are used* so that core hardness is not a factor in the test. Pronounced lack of ductility is identified with considerable spalling around the indentation. Relatively ductile material is indicated by the absence of spalling or cracking. Information of this sort has been collected from the specimens of three separate but experimentally identical 45-hr. nitriding treatments at 950 deg. F. and recorded in Table III. The examination was made on taper-ground square bars; only the surface layer of the case, up to 0.001 in. or less in depth, was found to exhibit spalling in any of the steels so it is only to this outer portion that the data apply. The low load employed and confinement of cracking to the surface layer make it unlikely that core hardness enters in any way into this ductility test.

Table III.—Vickers (10 Kg.) Hardness and Character of Indentation in Surface Layer (0.001 inch or less in depth)

	Treatment No.		
Steel	1	2	3
1A Al-Cr-Mo	895 Spalled	1064 Spalled	1003 Spalled
3A 2.5% Cr, Cr-Mo-V	782 Not Spalled	792 Not Spalled	803 Not Spalled
4A 4.5% Cr, Cr-Mo-V	974 Slightly Spalled	1033 Slightly Spalled	933 Not Spalled
5A 6.0% Cr, Cr-Mo-V	1003 Slightly Spalled	1003 Slightly Spalled	....

Table IV.—The Effect of Nitriding Upon Impact Strength (Specimens notched before nitriding)

		Vickers Hardness (10 Kg.)			
Steel	Condition*	Max.	Core	Izod Ft. Lb.	Loss Due to Nitriding Ft. Lb.
1A Al-Cr-Mo	Not Nitrided		245	88.0	
	Nitrided	1050	240	42.5	45.5
3A 2.5% Cr, Cr-Mo.V	Not Nitrided		285	74.5	
	Nitrided	890	290	32.5	42.0
4A 4.5% Cr, Cr-Mo-V	Not Nitrided		265	86.0	
	Nitrided	1030	260	62.0	24.0
5A 6.0% Cr, Cr-Mo-V	Not Nitrided		266	114.0	
	Nitrided	1100	280	58.5	55.5

* All specimens were quenched in oil from 1650 deg. F. and tempered at 1200 deg. F. before nitriding.

Although only qualitative, these data indicate that for equal surface hardness the chromium-molybdenum-vanadium steels are more ductile in the thin surface layer than is the aluminum-chromium-molybdenum steel.

The effect of nitriding upon toughness may be observed by a comparison of Izod impact strengths of nitrided bars and of similar bars subjected to the same preliminary heat treatment but not nitrided, as recorded in Table IV. Tests of this type, by bringing into play both the effect of the hard and less tough surface layer at the base of the notch and any temper-embrittlement that may have occurred in the core, indicate the full effect upon toughness that the nitriding treatment may produce. The impact values obtained preclude the possibility that temper-embrittlement occurred to any extent in the un-nitrided core of any of the specimens. Steels displaying this phenomenon to an important extent would have lower impact values either before or after nitriding, or both.

As already emphasized, the hardness and toughness of the core in the nitrided product are of peculiar importance because of the thinness and exceptional hardness of the case. Moreover, of all properties other than satisfactory nitrogen-hardening itself, the ability of the core to retain ample hardness upon long heating in the vicinity of 1000 deg. F. would seem to be one of the most valuable for many nitriding-steel applications.

Fig. 3 is a chart of the mechanical properties of the 2.65 per cent chromium, chromium-molybdenum-vanadium steel, presenting data secured with 1-in. round specimens, water quenched from 1700 deg. F. and tempered for 1 hr. (holding time) at the temperatures indicated. An outstanding property of this steel may be seen to be an unusually high maintenance of hardness, yield point, and tensile strength with increase in tempering temperature up to about 1100 deg. F. In Table V some of these tests are compared with data* on a steel similar to No. 1A and of the following composition:

Table V.—Mechanical Properties of Steels Tempered Above the Nitriding Temperature

Steel	Tempering Temp. Deg. F.	Yield Pt. P.S.I.	Tens. Str. P.S.I.	Elong. % 2 In.	Red. in Area %	Brinell
N 125 Al-Cr-Mo	1000	130,900	146,300	14.0	53.3	332
3 A*2.5% Cr, Cr-Mo-V	"	159,000	178,000	16.0	59.0	387
N 125	1100	112,300	126,800	15.5	58.5	293
3 A	"	152,000	169,000	17.0	62.0	370
N 125	1200	104,900	122,300	18.0	64.8	255
3 A	"	134,000	146,000	18.5	66.0	318

* See Table II for analysis.

	C	Mn	Si	Al	Cr	Mo
Nitralloy 125	0.26	0.50	0.13	0.95	1.04	0.21

This steel had been quenched in water from 1725 deg. F. in 1-in. round section. These data serve also to emphasize the unusual combination of ductility and strength obtained in the chromium-molybdenum-vanadium steel.

Similar data are available on other melts of the new type nitriding steel; the analyses of these and the mechanical properties obtained on one inch forged rounds, oil quenched and then tempered at 1000 deg. F. for two hours, are quoted in Table VI. A cast steel (C-0.19, Cr-2.35, Mo-0.37, V-0.27) also was heat treated in 1-in. (coupon bar) section. Two separate tests were made; the first, 8A-1, being oil quenched from 1650 deg. F. and tempered for two hours at 1200 deg. F. The second test, 8A-2, was first normalized from 1750 deg. F. after heating for 2 hrs. at temperature, then quenched into oil from 1650 deg. F. and finally tempered at 1150 deg. F. for 2 hrs. and air cooled. The results shown in Table VII present striking combinations of yield point and impact strength for a cast steel and mark this composition as of value also in parts not requiring to be nitrided.

These new steels are very fine grained both in the case and in the core and show the thin light etching layer at the outer edge of the case which has been observed by many investigators in the aluminum steels. The structure of this outer zone as well as that of the core in a chromium-vanadium steel containing 6 per cent chromium and 0.27 per cent vanadium is shown in Figs. 4 (a) and (b) respectively. It is this layer which causes the slightly lower hardness and ductility of the outermost portion of the nitrided case, and to which corrosion resistance usually is ascribed.

Table VI.—Cr-Mo-V Steels Tempered at 1000 deg. F.

Steel No.	Composition (Per Cent) C	Mn	Si	Cr	Mo	V	Quench. Temp.° F.
4A	0.14	0.69	0.32	4.47	0.54	0.20	1650
5A	0.18	0.60	0.20	5.70	0.53	0.18	1750
6A	0.51	0.76	0.26	4.68	...	0.19	1650
7A	0.20	0.49	0.26	4.15	0.45	0.26	1750

Steel No.	Yield Pt. P.S.I.	Tens. Str. P.S.I.	Elong. % 2 In.	Red. in Area %	Vickers Hardness (30 Kg.)
4A	146,250	192,600	17.5	59.6	405
5A	142,600	195,300	17.5	60.3	421
6A	178,450	192,450	12.0	41.0	400
7A	154,750	197,650	16.0	53.8	435

Table VII.—Mechanical Properties of a Cast Steel

Test	Yield Pt. P.S.I.	Tens. Str. P.S.I.	Elong. % 2 In.	Red. in Area %	Izod Ft. Lb.
8A-1	119,650	131,900	17.0	65.4	63
8A-2	138,350	152,850	15.0	46.0	40

Summary

A series of chromium-molybdenum-vanadium steels with moderately high chromium content has been shown to be admirably suited to nitrogen hardening. By selecting the proper proportion of chromium, a specific combination of hardness and depth of nitrided case may be obtained to suit the requirements of a particular application. In the nitrided product, case ductility as well as toughness of case and core combined, appear to be at least equal to those of the commercial aluminum steels. The microstructure of the nitrided case exhibits the thin surface layer which imparts corrosion resistance. These aluminum-free steels may confidently be expected to produce finished products of high quality, with avoidance of the manufacturing troubles inherent in steels of high aluminum content.

One steel of the new type, containing 2.65 per cent chromium, has been found to possess unusual mechanical properties peculiarly suited to the requirements of the core in nitrided work. Reference is made here to its outstanding maintenance of hardness and tensile strength together with excellent ductility and toughness (whether wrought or cast) upon tempering above the nitriding temperature, thus supplying better than ordinary support for the relatively thin surface layers of the nitrided product.

NOTE: British Patent No. 312,349 covers the use for nitriding of the steel compositions disclosed in this article. The Nitralloy Corporation owns the corresponding U. S. patent rights.

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* R. S. Sergeson and M. M. Clark, "Nitriding Analyses, Their Physical Properties and Adaptability." *The Iron Age*, 1930, Vol. 126, P. 992.

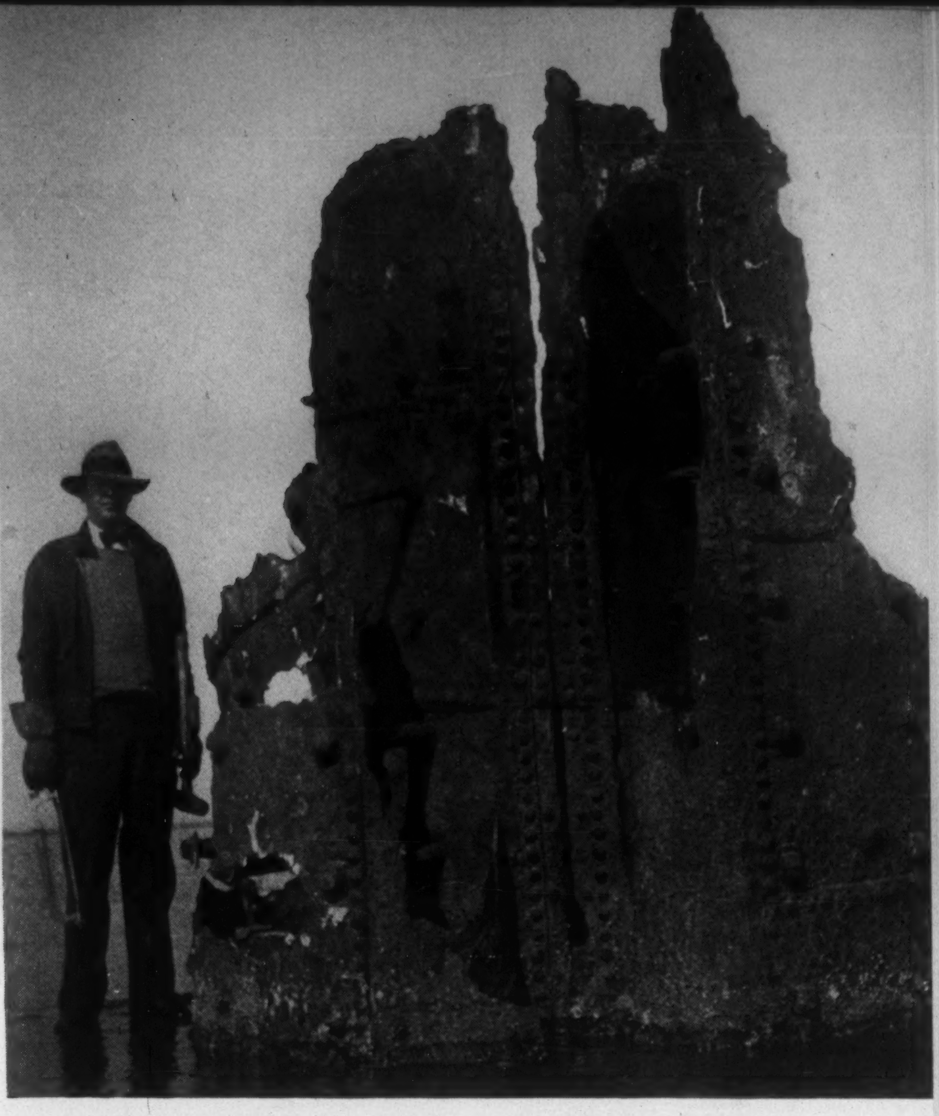

Fig. 1. Wreck of the "Clifton" as It Appears Today, Located Partly Submerged in Sea Water About 500 Yards South of the Old Fort Griffin.

American Wrought and Cast Iron of the Civil War Period

By H. M. Wilten and E. S. Dixon*

THE ECONOMIC SIGNIFICANCE of wrought iron has been long ago superseded by that of steel, but the former is of particular interest to the metallurgist because of its use in the very beginning of metallurgical history and because its method of manufacture has only recently been changed from hand to mechanical methods. This paper contributes to the many existing records of the durability of wrought iron.

The authors wish to acknowledge the courtesy extended by the officials of The Texas Co. at Port Arthur for the use of boats to visit the wreck of the "Clifton" and also for the use of the metallurgical laboratory equipment. The office of Naval Records and Library of the Navy Department in Washington was very kind in furnishing data on the history of the U. S. S. "Clifton." Thanks are also due the A. M. Byers Co., Pittsburgh, for its examination of some of the specimens and for information on the manufacture of wrought iron.

Historical Facts

Sabine Lake, on the extreme southern Texas-Louisiana boundary, joins the Gulf of Mexico through a channel called Sabine Pass, approximately 15 miles south of Port Arthur, Texas. On the Texas shore of the channel is situated the town of Sabine. This town had been an important seaport for many years before the Civil War and occupied a strategic site at the junction of the lake and the gulf. A series of earthen breastworks equipped with men and cannon was established for the protection of the town. This establishment was called Fort Griffin.

On Sept. 8, 1863, a portion of the Union Fleet under General Banks attacked the fort. During the engagement, the U. S. S. "Clifton" was disabled and eventually was grounded and abandoned about 500 yards south of the fort. Since the date of this battle, the wreck of the "Clifton" has been exposed to the sea and weather. A section of the funnel and steam chamber are practically all that now remain above the surface of the water. Fig. 1 shows the wreck as it appears at the present time.

The Navy Department records state that the "Clifton" was built in Brooklyn, New York, in 1861 under the direction of one J. Simonson, master builder. She was enrolled at the Port of New York by Cornelius Vanderbilt on May 31, 1861, and enrollment No. 55, covering the vessel, is on file at the Collector's Office, U. S. Customs Service in New York City.

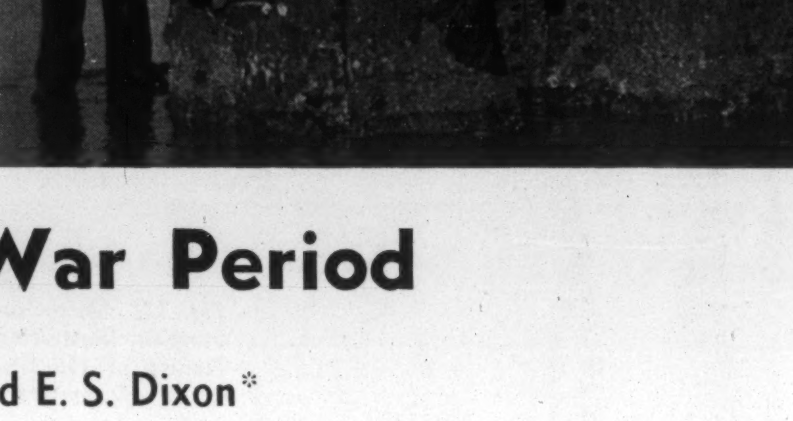

Fig. 2. A Boiler of the Period Believed to be Similar to That Found in the "Clifton."

No records of the design of the boiler are available and it is therefore impossible to learn the exact thickness of plates, size of staybolts and other parts. Fig.

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* Metallurgical Department. The Texas Co., Port Arthur, Texas.

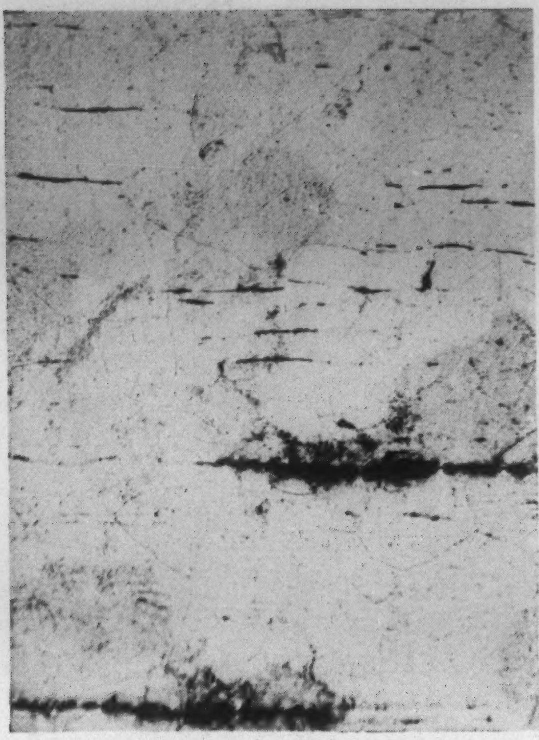


Fig. 9. Outside Layer of Plate, Illustrating Larger Grained Structure with Only Comparatively Little Slag. 100 Diameters.

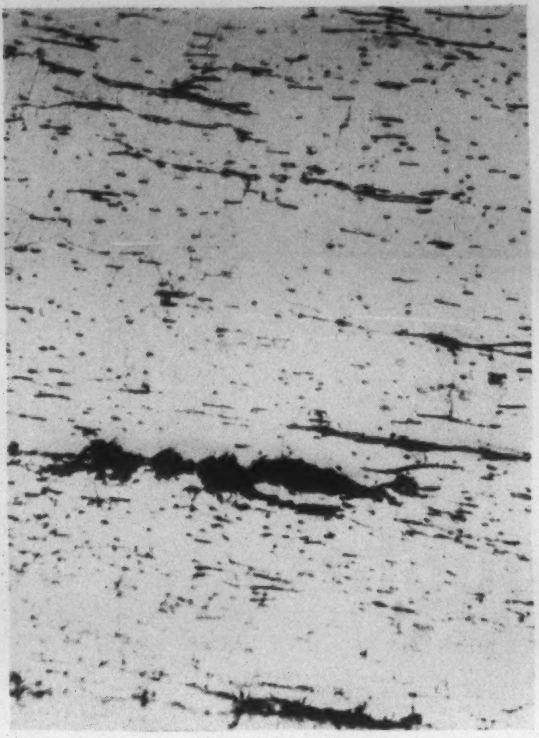


Fig. 10. Plate (Same as in Fig. 3) Inside Layer, Illustrating Small Grained Structure with Large Amount of Slag. 100 Diameters.

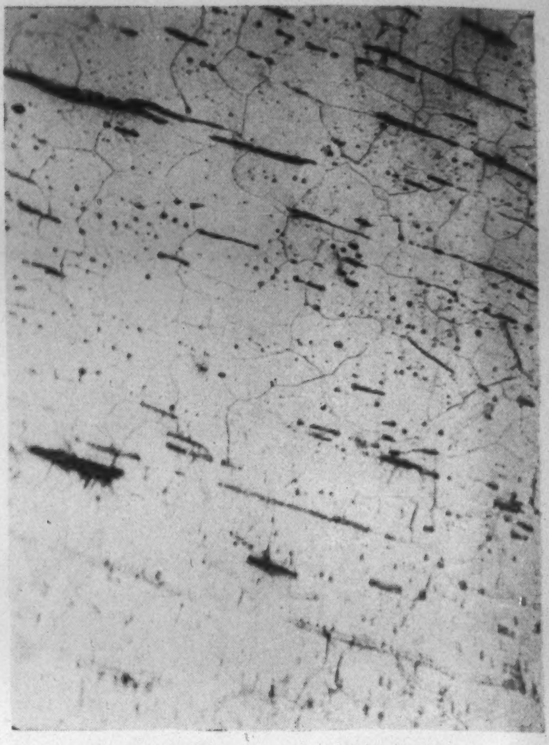


Fig. 11. Microstructure of Staybolt. Etched with Alcoholic Solution of Picric Acid. 100 Diameters.

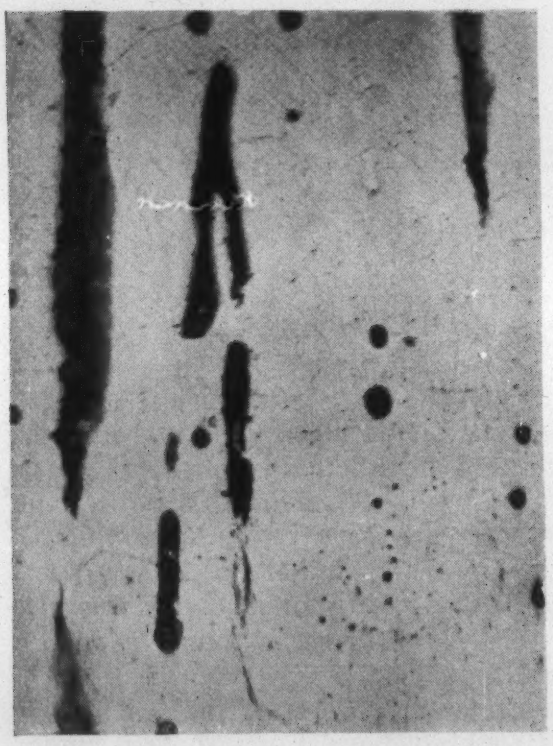


Fig. 12. Microstructure of Staybolt, Illustrating Duplex Nature of the Slag. 100 Diameters.

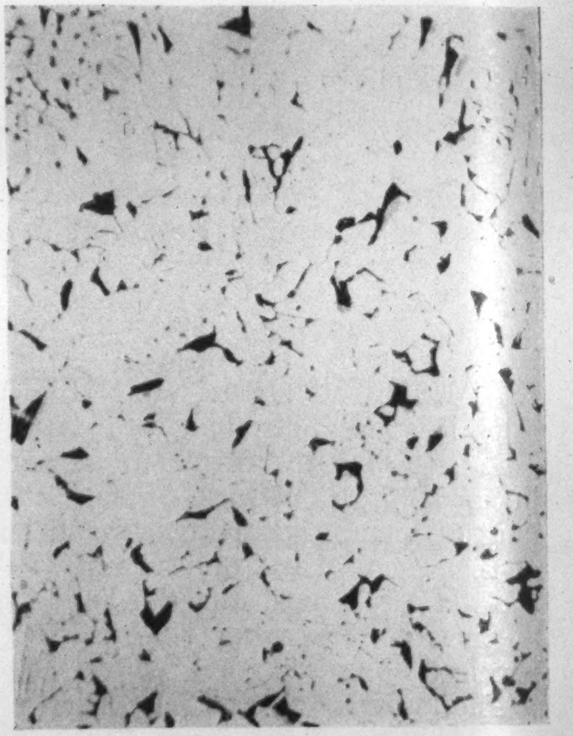


Fig. 13. Staybolt, Transverse Section. Pearlitic Area. 500 Diameters.

Fig. 14. Staybolt, Transverse Section. Pearlitic Area. 100 Diameters.

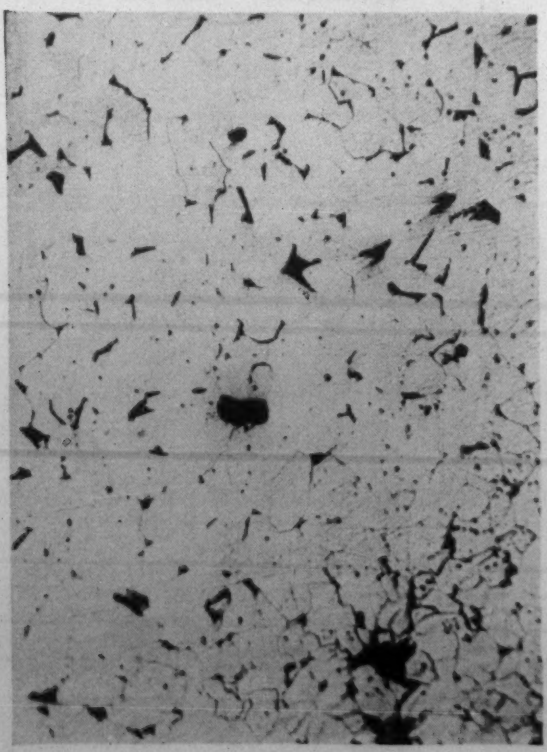


Fig. 15. Rivet, Longitudinal Section. 100 Diameters.

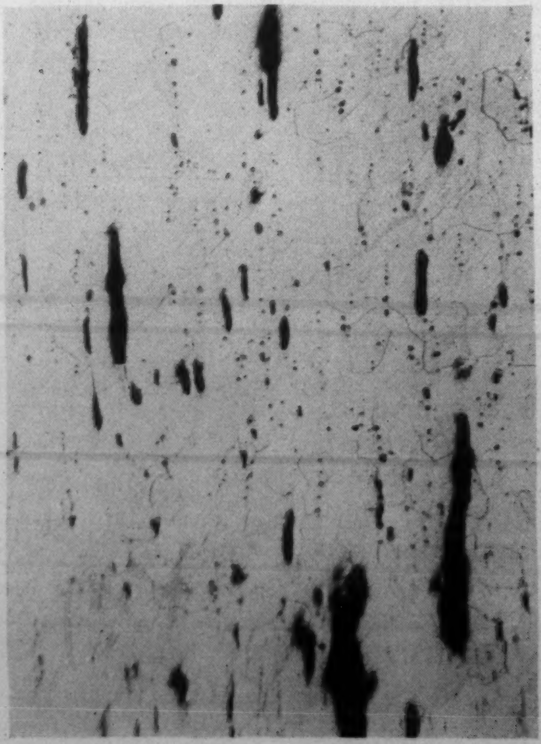
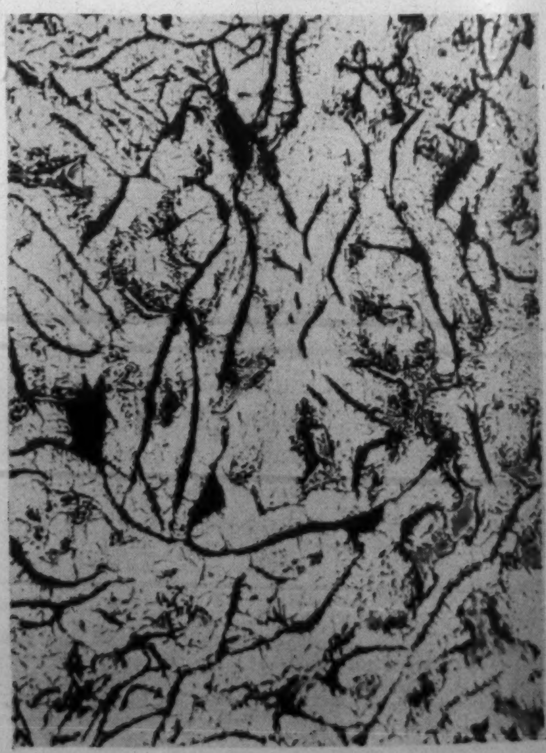


Fig. 16. Structure of the Cast Iron. 100 Diameters.



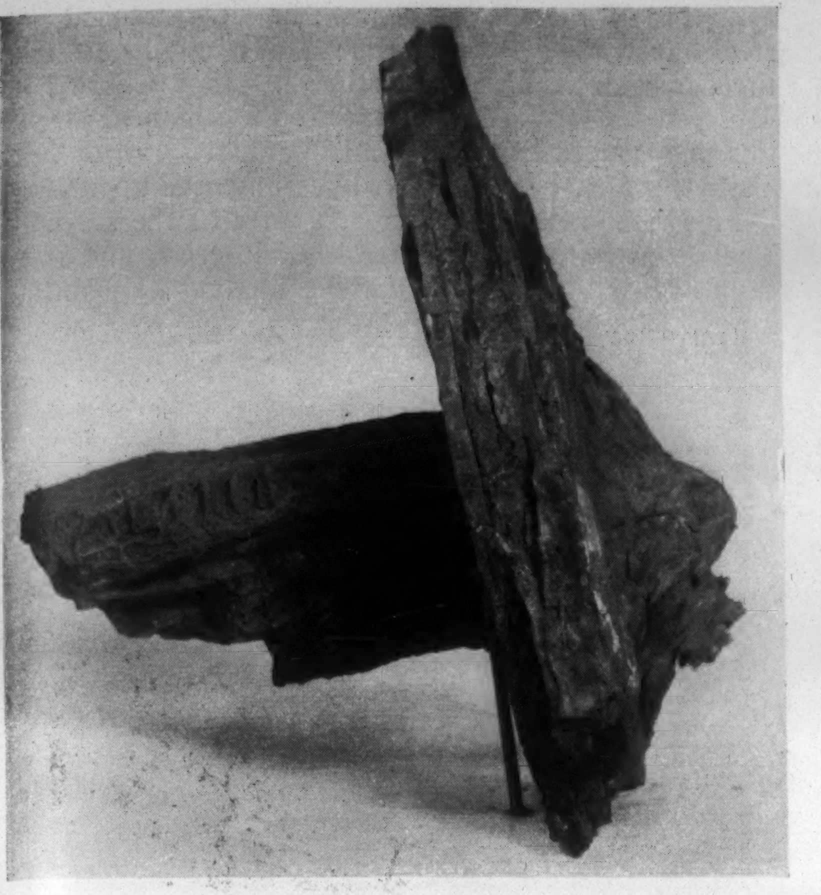


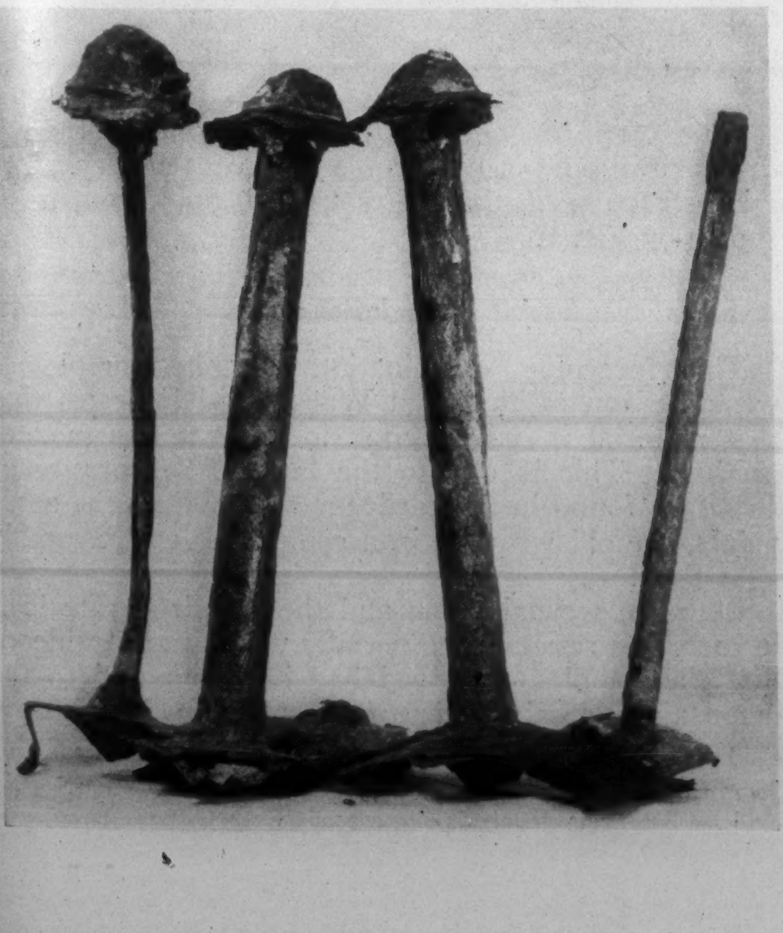
Fig. 3. Complete Deterioration of One of the Staybolts.

2, however, shows a boiler of the period which we believe to be similar to that found in the "Clifton." This sketch is taken from the "Treatise on the Steam Engine in its Various Applications to Mines, Mills, Steam Navigation Etc.," by John Bourne and published by Longmans Green and Co., London, 1868.

Metallurgical Examination

The samples for metallurgical examination were taken principally from that part of the stack and steam chamber about a foot above the water level. Fig. 1 shows how the portion of the stack exposed to the atmosphere corroded to a greater extent than the portion at the water's edge. Apparently the salt water spray is more severe than alternate complete immersion in water and exposure to air. Such a condition is not usually found in steel piling in sea water.

Fig. 4. Degree of Corrosion of Some of the Other Staybolts.



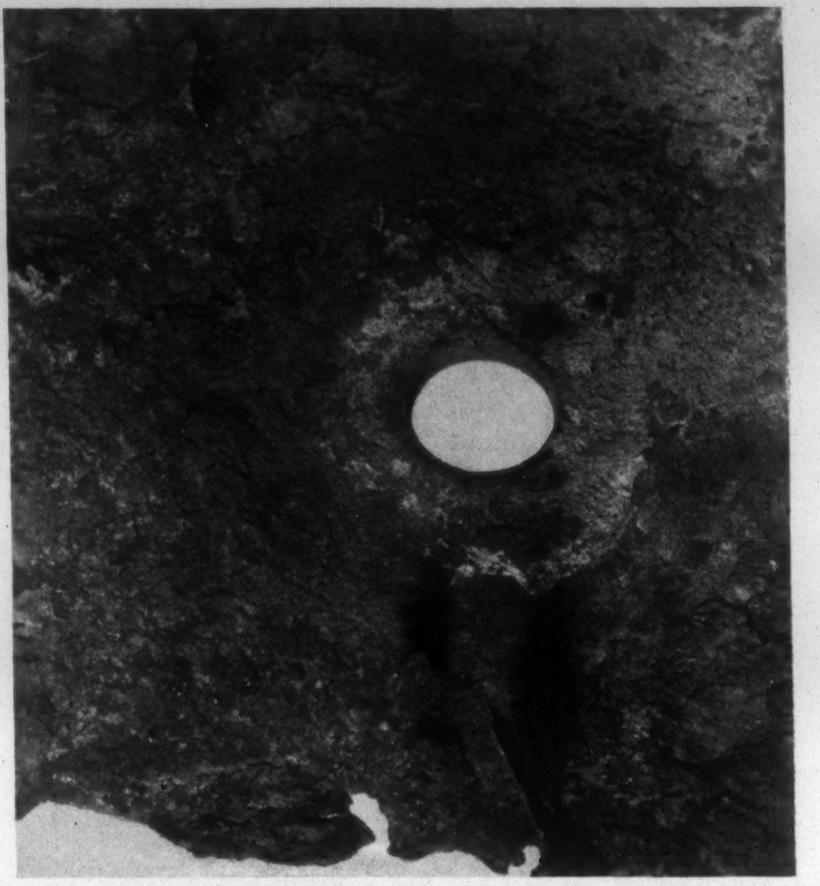


Fig. 5. Original Thickness of the Plate Could be Measured in this Section.

The complete deterioration of one of the staybolts and a piece of the plate is shown by Fig. 3. The fracture of the corroded plate appeared to be made up of layers of oxides ranging from yellow to dark red in color. These layers could be easily separated and, upon analysis, were found to contain the following percentages of iron:

First outside layer	75.9
Second outside layer	76.3
Third inside layer	74.0

Fig. 4 shows the degree of corrosion on some of the other staybolts. The one on the left has thinned down from an original diameter of 7/8 in. and the one on right has the scale still intact. The two staybolts in the center are covered by spacers which are used to separate the stack from the outer plate of the steam chamber. In one case, the staybolt head and spacer protected the plate so well that the original thickness of the plate could be measured. This case is shown by Fig. 5. The plate was found to be 1/4 in. thick while the surrounding metal had corroded away to 1/16 in. Chemical analysis of the various samples is outlined in Table I.

Table I.—Chemical Analyses of Staybolts and Other Material

Material:		C	Mn	S	P	Si	Cu	Slag
Staybolt	No. 1	0.086	Trace	0.031	0.218	0.10	...	3.62
	No. 2	0.072	....	....	....	....	0.04	...
	No. 4	0.064	....	....	....	....	0.21	...
	No. 2*	0.096	0.041	....	0.195	0.197	...	...
	No. 3*	0.130	0.037	....	0.163	0.178	...	...
Plate		0.032	0.06	0.028	0.189	0.17	...	...
Rivet		....	0.11	0.009	0.152	0.11	...	...

* These analyses were made by the A. M. Byers Co.

The chemical analysis presents nothing out of the ordinary except for the fact that a higher percentage of carbon was noted than is usually found in present day wrought iron. Staybolts Nos. 2 and 4, though differing in copper content, appeared to have corroded similarly.

Tensile tests were made on a standard 2-in. gage

0.505-in. diameter specimen. Staybolts had to be used for this test because no suitable sample of the plate could be obtained. The results of the test are given in Table II.

Table II.—Tensile Properties of Two Specimens

	No. 2	No. 3
Yield point, lbs. per sq. in.	29000*	31250*
Tensile strength, lbs. per sq. in.	48500	50000
Elongation, % in 2 in.	36.0	36.0
Reduction of area, %	40.3	38.8

* Yield point was obtained by the drop of the beam method.

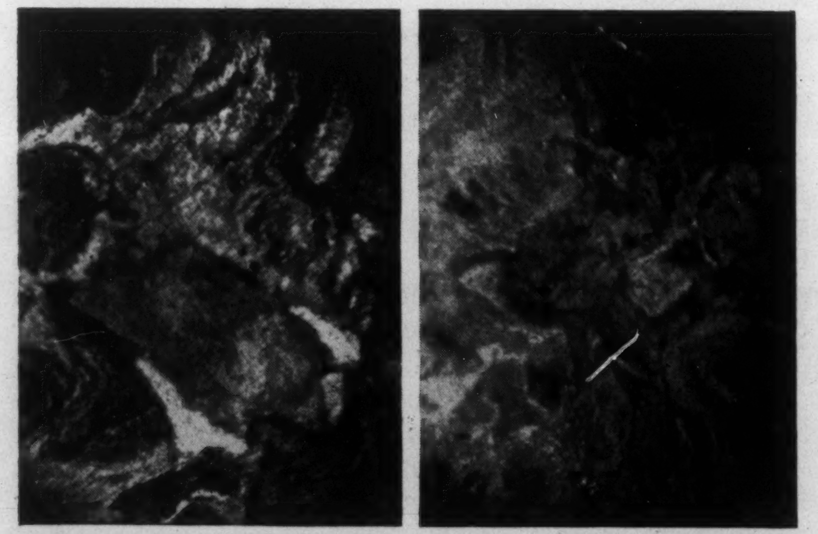
It is interesting to observe the high elastic ratio (which is probably due to the high phosphorus content), and also the small difference in values of the percentages of elongation and the reduction of area.

Impact tests were made on a Charpy 30 KgM machine. Both standard keyhole and Izod "V" notch specimens were used. The impact values and the nature of the fractures are shown in Table III. The correlation between the impact strength and the resulting fracture should be noted. In general, the greater the crystalline area of the fracture, the lower the impact value. The impact values given by the keyhole notch and the "V" notch were nearly the same as distinguished from the variation in value obtained from a test of steel specimens. The values for steel are given in Table IV.

Table III.—Impact Tests of Various Samples

Spec.	Notch	Ft.-Lbs.	Brinell 1000 Kg. Load	Fracture
11[1]	Standard[2]	23.5	90	Rough 5% crystalline area
12	Standard	26.2	90	Rough Few crystalline specks
21	Standard	30.6	85	Rough Few crystalline specks
31	Standard	18.8	95	Rough 10% crystalline area
32	Standard	27.0	101	Rough 25% crystalline area
11	Alternate[3]	47.5	95	Rough No crystalline area
12	Alternate	27.0	95	Rough 20% crystalline area
21	Alternate	28.4	101	Rough 20% crystalline area
22	Alternate	23.4	90	Rough 75% crystalline area
31	Alternate	28.4	101	Rough 75% crystalline area
32	Alternate	44.1	90	Rough 5% crystalline area

[1] Specimens No. 11 and 12 were taken from the same staybolt, 21 and 22 from another, and 31 and 32 from a third.
[2] Standard keyhole notch; specimens 2.361 in. long.
[3] Alternate Izod "V" notch 0.079 in. deep which is standard for Izod specimens.



Figs. 6 and 7. Macrostructures of Two of the Staybolts, Revealing Heterogeneous Structure. 5.5 Diameters.

Table IV.—Charpy Impact Properties of Annealed Steels in Foot-Pounds

Material	Standard Keyhole Notch	Izod "V" Notch	Brinell
Mild steel	59.0	149.4	85
5% chromium steel, low carbon	54.5	126.0	160

The data in Table IV indicate that a notch exerts a greater effect on wrought iron than on steel when, as a matter of fact, it is easier to break a notched mild steel bar with a hammer than a wrought iron bar of the same size. This is another instance where laboratory tests do not corroborate the mechanical properties of wrought iron as found in actual service. Such a situation has been previously commented upon*

Figs. 6 and 7 show macrostructure of the staybolts. The heterogeneous structure is of interest, and is accounted for by the fact that the method of manufacture involved a "busheling process."

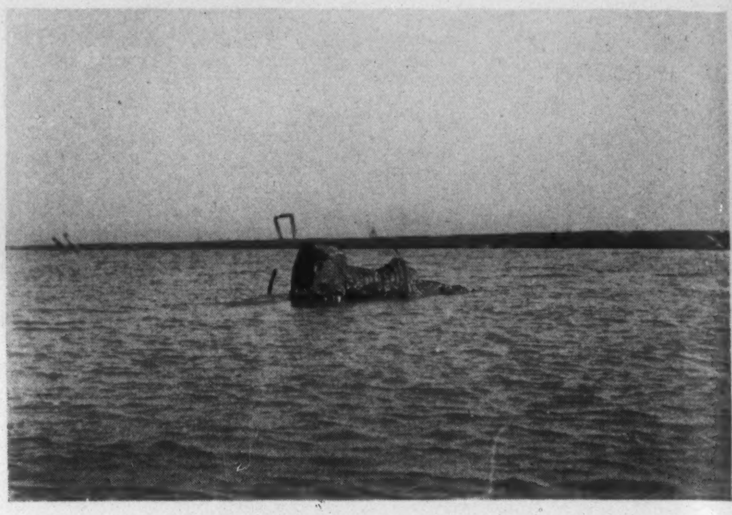


Fig. 8 The Anchor Winch of Cast Iron.

Microstructures of the plate metal show nothing unusual. There was some rolled-in scale in the staybolts. Figs. 13 and 14 show pearlitic areas which are probably due to incomplete refinement of the material.

Cast Iron in the Wreck

In addition to the examination of the wrought iron, a few specimens of cast iron from the ship were also studied. The samples were taken from what appeared to be the anchor winch, shown in Fig. 8. There was practically no indication of corrosion, though it lies partially submerged. An analysis of the cast iron gave:

Total carbon	3.04	per cent
Graphitic carbon	2.91	per cent
Manganese	0.79	per cent
Sulphur	0.05	per cent
Phosphorus	0.756	per cent
Silicon	2.17	per cent
Copper	0.02	per cent

This cast iron contains more phosphorus than is ordinarily found in modern cast iron machinery. The microstructure is that of a typical gray iron, as is shown by Fig. 16.

Conclusions

The foregoing examination of one sample of wrought iron of the Civil War period indicates that that material is only slightly inferior to the modern product. This is due to the lack of uniformity of structure found in the earlier metal. On all the other points, the old wrought iron compares very favorably with the new.

Both the wrought iron and the cast iron rate high in corrosion resistance, especially when it is considered that the samples examined had been exposed to the damp air and salt water of the Gulf of Mexico for 71 years.

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* Gillett, H. W., "Wrought Iron, Some Pros and Cons and the Need for Research," *Metals & Alloys*, January, 1931, Page 25.

Some Fundamentals of

SPOT WELDING

Especially of the Light Alloys

By Raymond H. Hobrock*

Part 3

(Continued from February)

The Influence of Time on the Spot Welding

It is common practice in the welding of aluminum alloys and stainless steels to use control systems in connection with the spot welding transformer to limit the flow of electric current very accurately. The time during which the heavy current flows is sometimes as little as 1/120 second. The pressure on the electrodes, however, is usually maintained a much longer period of time. Yet the pressure exerted by the electrodes on the pieces is usually not great enough to produce a cold deformation. The actual deformation occurs during that interval when the material is at a sufficiently high temperature to be deformed by the electrode pressure. It is important, therefore, to examine the influence of time, first on the deformation, and second, on the recrystallization.

Little is known about the effect of very rapid deformations at elevated temperatures upon the size of the crystals after recrystallization. However, for this analysis we might examine first of all the probable effect of the very short time application of a force on the deformation itself. It is well known from a study of creep phenomena[11] that, especially at elevated temperatures, the deformation of a metal under a constant load is a function of time. This is also shown in a study of the impact work values of metals at elevated temperatures. Fig. 26 shows such impact values in curve 2, and the strength values in curve 1, for electrolytic iron. It is seen that although the maximum tensile strength reaches a low value at 600° C., the value for the impact work is a maximum at this temperature. This is probably due to the fact that slippage along the glide planes is a process requiring some time. In making the maximum tensile strength curve, this time was sufficient so that gliding occurred and eventual failure along the glide planes. However, the speed of applying the load in the case of the impact test was so great that little or no gliding could occur, and the measured impact work indicates the work required to disrupt the cohesive forces in the crystalline aggregate, rather than work done in causing plastic deformation.

If, then, the time interval during which the force is applied to the metal at an elevated temperature by the electrodes of a spot welding machine is very short, the resulting deformation may not be as great as might be expected from a consideration of the stress-strain curve for the metal at that temperature. However, in the case of the aluminum alloys, the temperature at the weld spot may exceed the maximum temperature allowable for hammer welding, as shown in curves a and b, Fig. 5. In this case the material in the grain boundaries will have been molten, and the mushy metal is readily deformed. Its impact work above this temperature would be very nearly zero. In this case, however, if the deformation is not great enough, the higher melting crystals will not be deformed, but will slip as whole crystallites in the material already melted. A weld made under such circumstances would then be cemented together by the crystallization from the melt of the lower melting point constituent. In the original material this lower melting point constituent had probably been prevented from separating in any considerable amounts from the mixed crystals by proper heating and quenching. The influence of such welds essentially cemented together by the lower melting point constituent of an alloy, on the strength properties of the weld, will be determined by future experiments. Observations have, however, been made on actual spot welds of Alclad sheet, in which the higher melting point aluminum coating has not been completely melted, but is held intact in the weld spot. See Fig. 22.

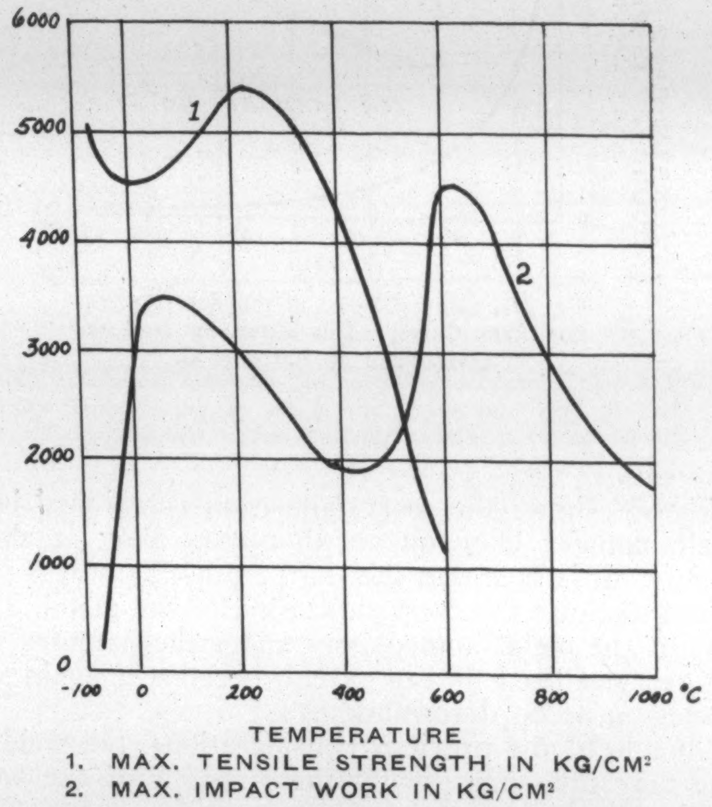

Fig. 26. Curves Showing the Values of Tensile Strength and Impact work for Electrolytic Iron at Elevated Temperatures.

Tammann[3] has shown that the linear rate of grain boundary displacement in a polycrystalline solid that has been deformed and allowed to recrystallize, bears a hyperbolic relationship to the time of recrystallization. See Fig. 27. From this it is seen that at very short time intervals the rate is very high. It may be expected, therefore, that even the short intervals of time used in making some spot welds will not materially affect the recrystallization. As a matter of fact, the short interval of time is desirable in that it prevents to some extent the growth of larger crystals.

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* Daniel Guggenheim Airship Institute, Akron, Ohio.

[11] A. Nadai. Plasticity. McGraw-Hill Company, New York, 1931.

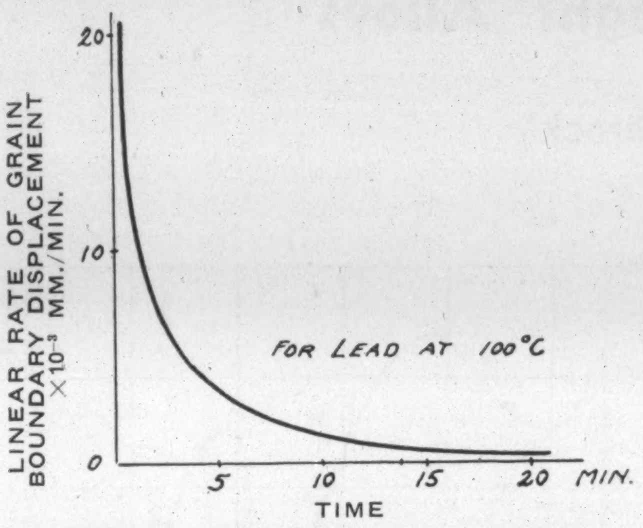

Fig. 27. General Shape of the Recrystallization Rate Curve. This curve for lead recrystallized at 100 deg. C.

Fig. 28 shows the recrystallization occasioned by a small hammer blow on an aluminum alloy at about 450° C. It is seen that the sharp, quick blow was sufficient to cause the recrystallization of the metal. That part of the metal immediately under the hammer was not recrystallized to any extent, because it again was the region of no deformation.

Outside of the previous considerations, the welding time may influence greatly the strength of the weld in other ways.[12]

Curve b of Fig. 29 shows the relation between the strength of the weld spot in duraluminum and the thicknesses of the sheets welded together. In the small sheet thicknesses, the strength shows a linear relation to the sheet thickness; however, above a sheet thickness of about 1 mm., this relationship drops off rapidly. This is due to the longer times and higher temperatures used for the thicker sheets in their effect on the strength properties of the weld spot, and especially on the sheet near the weld spot. If the welded pieces are later heat-treated in order to again bring out the most desirable properties, the strength of the weld spots increase and then fall all on curve a. For comparison, curve c shows the strength of similar sheets riveted together.[13]

Fig. 28. Recrystallization Due to Small Hammer Blow on an Aluminum Alloy at about 450 deg. C. 3.5X

The Mechanical Working of the Weld Spot

Mechanical working of a recrystallized structure is desirable, since it increases the strength properties and also assists in most effective precipitation hardening. It is probable that the weld spot made in a spot welding machine is mechanically worked during the cooling of the spot. This working may have its origin in two different phenomena: 1. the change in electrode pressure during the welding time, and 2. the cooling of the metal under pressure.

Since most spot welds are made with alternating current, the effective pressure of the electrodes on the metals to be welded varies with the magnitude of current flowing, due to an opposing force tending to open the electrodes. This opposing force has its origin in the circulating currents induced in the pieces being welded, and is dependent on the shape and size of these pieces. Such circulation currents set up a magnetic field opposing the field surrounding the secondary conductors and electrodes, and thus cause a force tending to separate the electrodes. It is readily seen that as the alternating current increases from zero to its peak value, the effective pressure of the electrodes on the pieces will decrease from the initial electrode pressure to some smaller value. Thus, during one cycle of the flow of current, there will be two cycles of pressure change. This "hammering" effect may be most desirable in its effect on the weld spot and the material immediately under the electrodes.

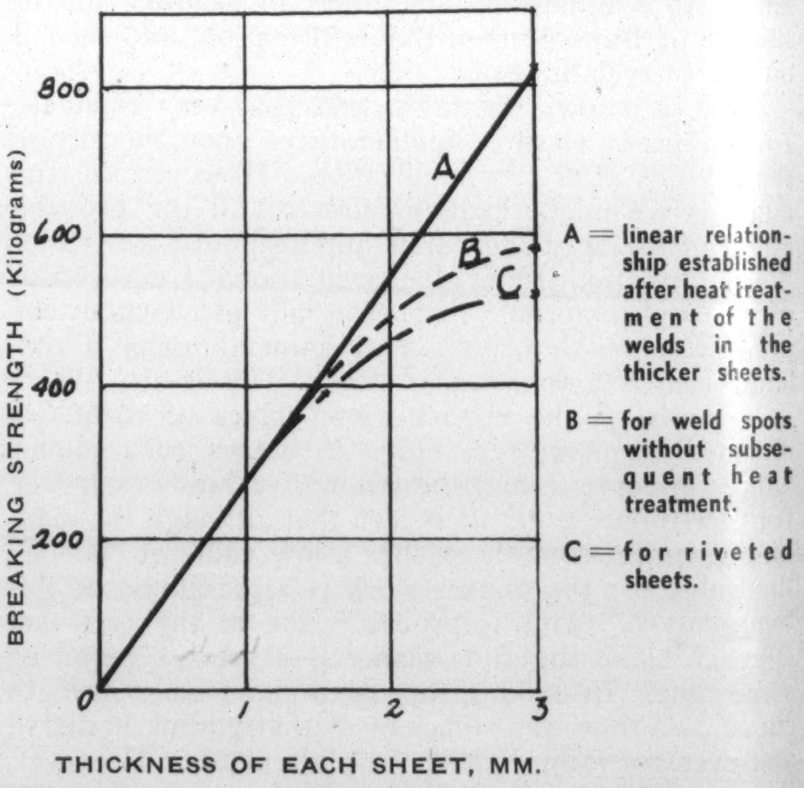

Fig. 29. Curves Showing the Relation between Sheet Thickness and the Strength of a Spot Weld Made in the Sheets.

In experiments on pressure welding of electrolytic iron in vacuum, Esser[4] found that if the pressure was maintained on the specimen while it cooled to about 100° C., the strength of the welded portion increased from about 33 to about 36 kg./mm.^{2}. He ascribed this increase to a probable working of the specimen during the time of cooling. Since weld spots are maintained under electrode pressure during the rapid cooling period, it is possible that in this way the strength properties are somewhat increased.

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[12] Schwarz & Goldmann. *Zeitschrift fuer Metallkunde,* Vol. 25, 1933, pages 142, 194.

[13] P. Brenner. *Luftfahrtforschung,* Vol. 1, 1928, page 35.

The effect of the magnitude of the specific electrode pressure may then affect the properties of the weld spot in various ways:

1. It affects the deformation and the resulting grain size after recrystallization.
2. It affects the working of the spot during cooling.

Furthermore, the shape of the secondary of the welding transformer and the electrodes, the magnitude of the secondary current, the number of cycles during which the current flows, the size, shape, thickness, and specific resistance (as well as the magnetic properties) of the metal to be welded, together with the initial specific electrode pressure, will be factors influencing the working of the weld spot by "hammering" of the electrodes.

Influence of Surface Conditions

It is obvious that the condition of the surface of separation of the two pieces to be welded, as well as the surface condition under the electrodes, will be of great influence in spot welding. Since the greatest heat will be generated at the point of highest resistance in the electrical circuit, every attempt must be made to concentrate this heat at the point of contact of the two pieces to be welded. If either of the electrodes makes poor contact with the piece, considerable heat will be generated at that point. This may or may not lead to burning at the electrodes. In the case of properly designed, water-cooled electrodes, burning will perhaps not often occur. However, the resistance of the secondary circuit has thus been increased and the secondary current correspondingly decreased, so that the heat generated in a fixed time at the face of separation of the pieces to be welded has been decreased and may lead to a poor weld. Furthermore, too much heating at the point of contact of the electrodes often leads to rapid deterioration of the electrode shapes and alloying of the material of the electrodes with the metal being welded. Such alloying, in the case of aluminum and the light alloys used in some types of aircraft construction, may lead to serious corrosion difficulties, due to the formation of local electrical couples.

Because of the dielectric and mechanical strength of the oxidation compounds of aluminum, the problem of the surface conditions requires special study where these metals and alloys are to be spot welded. Under certain circumstances it may be found desirable to build special spot welding transformers with a higher secondary voltage and poorer regulation than normally used, in order that the higher voltage might assist in breaking through the oxide and nitride films on the surface. Other methods, such as the special oxidation of the sheets on that side where they make contact with each other (not on the electrode side), the use of aluminum foil between the sheets to be welded, etc., have been tried, and in some cases, used with success.[14]

However, outside of the influence of surface films and other surface conditions on the generation of the Joule heat, the roughness of the surface seems to be of importance, in itself, on the strength of the weld. Fig. 30 shows a curve correlating the temperature at which the greatest weld strength was obtained with the smoothness of the surface in terms of the designations of the polishing papers used in the preparation of the surfaces.[4] The welding pressures in all cases were maintained at 2 kg./mm.^{2}. From this curve it seems that highly polished surfaces produce the welds of greatest strength. This may be due to the more intimate contact of the crystallites in the surface of the material to be welded. The effect seems to be large, at least for electrolytic iron, for which these curves have been made. Whether or not such a large effect will be noticed in the case of aluminum and the aluminum alloys remains to be determined by future experiments.

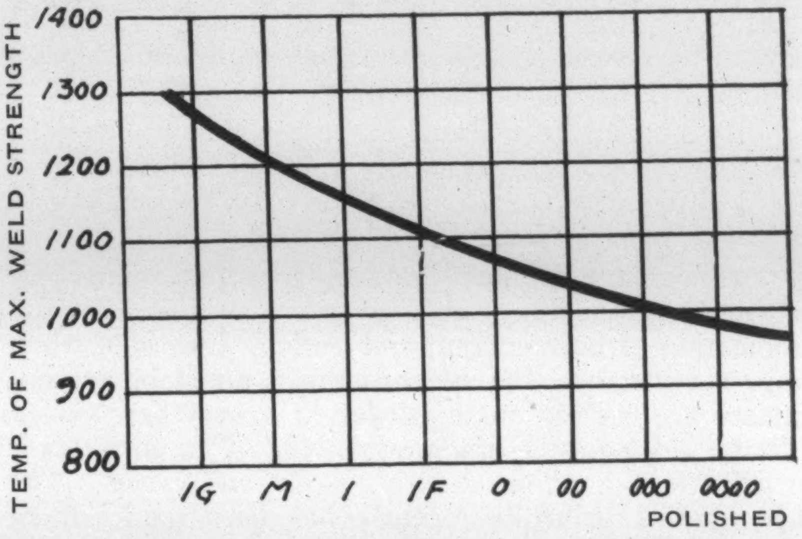

Fig. 30. Relation between the Smoothness of the Surface and the and the Temperature at which the Maximum Weld Strength was Achieved. (For electrolytic iron.) (Esser)

Resume

An explanation of the mechanism of welding below the melting point is proposed and some of its aspects discussed. The influence of some of the many factors involved in spot welding technique, such as the nature and composition of the metals to be welded, the influence of pressure and electrode shape on the size and shape of the spot, the influence of the nature of the surface of the metal to be welded on the strength of the weld, the sources of mechanical working of the spot and the effect of this working on the strength of the spot, the influence of the time during which the current flows as well as the influence of the magnitude of the current on the strength of the spot, and various other factors, are discussed from a theoretical standpoint and illustrated by some experimental results.

In general, it is proposed that spot welding, much like hammer welding, is due to recrystallization of the metal at temperatures below the melting point. This recrystallization is affected by deformation of the metal and by the recrystallization temperature. These factors of deformation and temperature, and how they are influenced by the mechanical and electrical structure of the spot welding machine and its control apparatus are discussed in their probable relation to the strength and reliability of a spot weld.

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[14] Bohn & Hoglund. *Welding Engineer*, Vol. 18, 1930, page 25.

(Concluded)

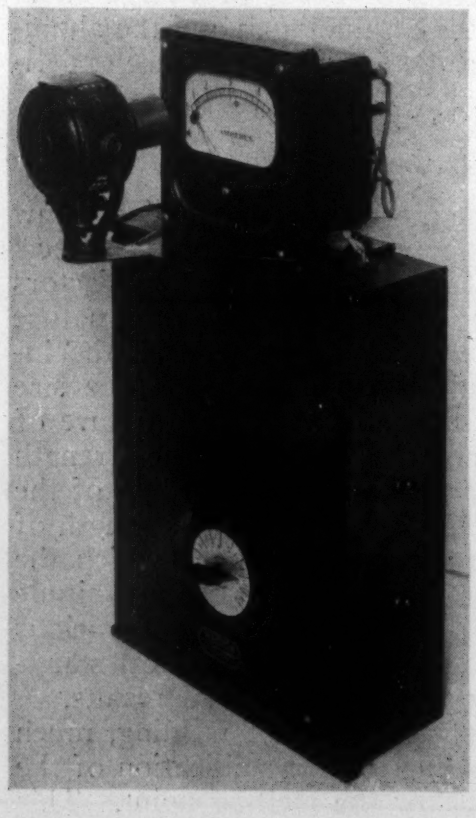
Light Beam Indicator For Aluminum Resistance Welding

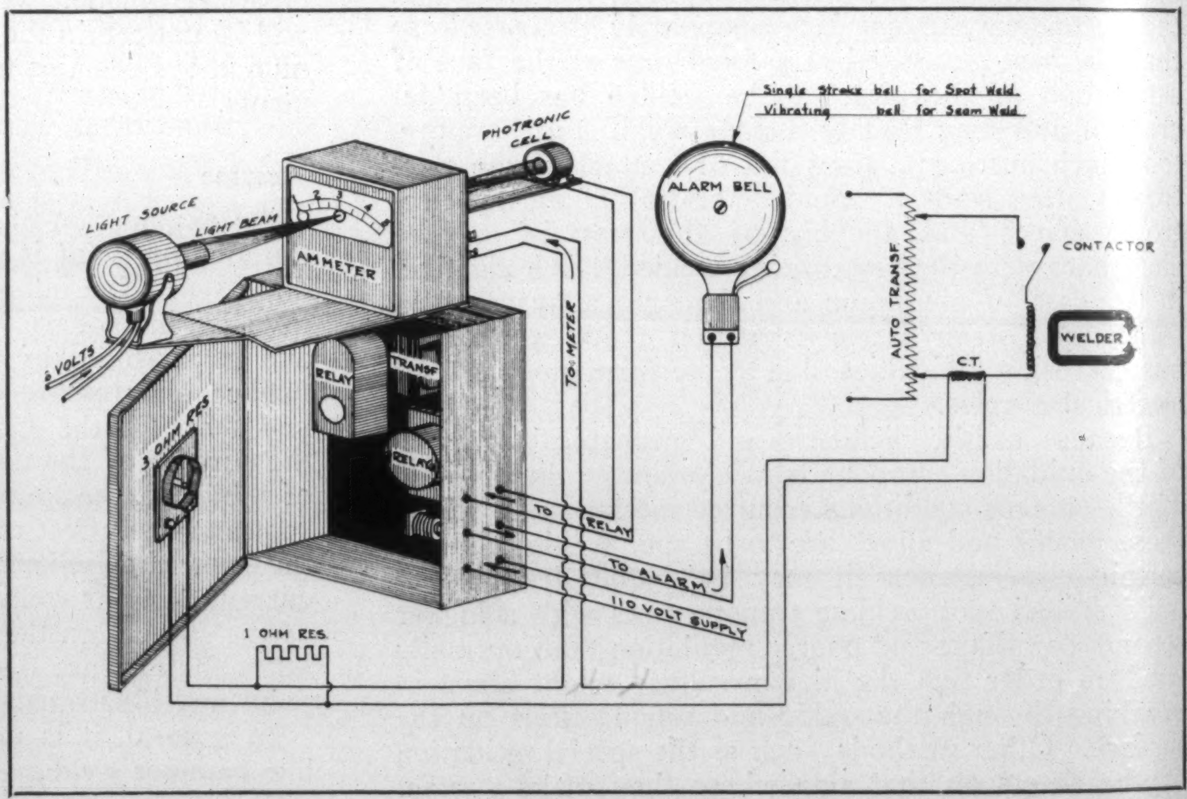
By D. I. Bohn*

PRECISION CONTROL OF ALL factors concerned is the basis of successful spot and seam welding of the aluminum alloys. Electronic synchronous timing has made such necessary accuracy entirely practical.

It has been felt desirable for production applications, however, to check constantly on the maintaining of such adjustments as may be made for a particular spot or seam welding job.

An ordinary ammeter connected in the primary circuit of the welding transformer is a most excellent indication of both current and timing. For spot welding, for instance, the synchronously timed power impulses are usually on the order of a very few cycles. For this reason, the maximum swing of an ammeter is a ballistic indication of both current and cycles. The use of this principle recently has been made in an equipment which indicates to the operator, for each spot when spot welding, and continuously when seam welding, that his adjustments of cycles and current have not altered.





The illustrations show schematically the arrangement employed. An AC ammeter is provided with a small hole in the center of its dial, so arranged that the pointer covers up the hole whenever it swings high enough. A beam of light is focused through this hole and impinges on a photronic cell in the rear of the instrument. Through suitable relays, the photronic cell is caused to ring a bell whenever the light is intercepted.

By means of a shunting rheostat in the current transformer circuit, the amplitude of the meter may be adjusted for any given setting of current and cycles so that its maximum swing intercepts the light beam.

THE importance of control in spot welding of the light alloys has been emphasized in the article by Hobrock in the January and February issues. The third and last portion appears on other pages in this issue.

This description of one means for such control serves to supplement the Hobrock article.

So long as these adjustments remain intact, the bell will be caused to ring once for each spot. If for any reason the cycles or current, or both, increase, the pointer will overtravel and two rings will occur. If it does not swing far enough, the bell will not ring at all.

When used for seam welding, the connection to the bell is reversed so that it will ring whenever the light source is not interrupted. This means that during the making of a seam using synchronously interrupted power, if the initial adjustment is made so that the pointer continuously intercepts the light beam, the bell will not ring, but if any variation in cycles or current occurs, the operator's attention is immediately called to this change in conditions.

A conventional type of recording ammeter, or other instrument, is not satisfactory when used ballistically, as is the case with spot welding, as the consistency of results will depend greatly upon pen friction, ink viscosity and other features which do not interfere with the instrument's accuracy when used in the normal manner.

A simple form of marking recorder may, of course, be used in place of the bell, so that for any given production job a final record is available on a tape for an inspector's study.

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* Aluminum Company of America.

Courtesy of The Midvale Co.

The Physical Chemistry of Steel Making—

Last Chapter in the Cooperative Work on This Subject

An Extended Abstract

NEARLY ten years ago, the Bureau of Mines decided that the so-called deoxidation processes in steel making had so much to do with the quality of the finished steel that it was to the public interest to study them and throw light upon them.

The work was located at the Pittsburgh station of the Bureau, and was carried on with the cooperation of Carnegie Institute of Technology. An advisory board of steel makers of which T. D. Lynch was the first, and Dr. F. N. Speller the later chairman, was set up to guide the investigations. Dr. C. H. Herty, Jr., a member of the staff of the Bureau of Mines, was put in charge of the work, aided by assistants from the Bureau of Mines staff, and by research fellows of Carnegie Tech., whose work under Dr. Herty served as thesis work for advanced degrees at Tech. The work was reported in "Cooperative Bulletins" of which a dozen were issued in 1927-1932, and verbal reports made at the annual "open meetings," which grew till the sessions had an attendance rivaling, both in size and in standing of those attending, those of a national technical society.

Cooperation of industry, as to advice, facilities for plant work and funds for payment of research fellows, was obtained from the start, and was the more enthusiastically given, the more evident it became that the work was aimed at the solution of practical problems and was being reported in terms that open-hearth operators could understand with the education they got in the open meetings and in contact with the experimenters.

The work was receiving national and international recognition when, three years ago, the Bureau of Mines decided to withdraw its support, so that no more Government funds were available. A new administration had come in a while before and the former administration's plans were step-children. This threw the financing wholly upon industry, and the Metallurgical Advisory Board had to take over the financing and assume direction, becoming the governing, rather than the advisory, body. Scarcely had this been done when the depression appeared, and it was an up-hill job to finance any cooperative research project, even one so important and so well established as this. Dr. Herty was retained to continue the work but it was impossible to give him as many assistants as formerly, and the equipment formerly available in the Bureau of Mines laboratory could no longer be utilized. The use of the well-equipped research laboratory of the National Tube Co. was promptly tendered and this solved the housing problem. It became evident that some of the firms cooperating were becoming more interested in following up some special angles of the work in their own plants for their own advantage, without making their findings public than to pursue further the fundamentals for the benefit of all.

Hence, the program became the rounding off of the projects already in hand without planning for the extensions that would have been logical, had the project been a continuing one. Experimental work was concluded in the fall of 1934. It is the desire of Carnegie Tech. that the Metallurgical Board be continued, and no doubt this will be done.

It is fruitless to speculate on whether the cooperative group would have held together had the personnel of the Bureau of Mines not changed so that those with major interests in other fields had not come into control, or whether the types of work that have been taken up in place of this broad problem will ultimately prove more or less valuable than this.

It is regrettable that so well publicized a cooperative organization has fallen apart, for there was still much of importance to do that could have been done very effectively by those with the background of the prior work. Its cessation will be interpreted by some as indicating that the idea of cooperative research has had a setback and that the steel industry is no longer cooperatively minded.

We are inclined to interpret it otherwise. The main objectives in the study of fundamentals pertaining to steel making have now been accomplished. The steel industry has had many code, labor, and other irritations to contend with in the last couple of years and the executives have had little time to consider matters that in more normal times they would give thought to and the lack of an appropriation for cooperative work of this sort does not necessarily mean disapproval of such things. That the cooperative group held together so long and so effectively in spite of the vicissitudes indicates that, for a sufficiently important purpose, cooperative effort can be had.

Such a large amount of fundamental data has been assembled in scientific order, as a result of this work, that it may perhaps be just as well in the long run that this be assimilated into practice before attempting to extend the program along other lines.

The swan song of "The Physical Chemistry of Steel Making" has been given in half a dozen bulletins by Dr. Herty and associates. These are of sufficient interest and permanent value to deserve more detailed abstracting than would normally be afforded in our abstract section, so we give extended abstracts of them in the paragraphs which follow. These reports are available in a single bound volume for permanent reference. A complete bibliography is also available in another volume containing over 400 pages.—H. W. Gillett

The Final Reports to the Metallurgical Advisory Board

S. Epstein[*]

IN reporting[1] on their last year of work, Herty and his co-workers have prepared six very substantial papers.[2] The papers cover the whole range of Herty's research work on the physical chemistry of steel making from slag control and deoxidation to grain size and aging characteristics of steel, and represent the culmination of his eight years' effort.

Herty's greatest success has been in popularizing the physical chemistry of steel making and in exciting an interest in it among research men and operating men alike. As a result, he attained in effect the active cooperation not only of his immediate co-workers and associates but of the whole industry in trying out his suggestions and in contributing fresh ideas. By serving as a clearing house for all this activity, he greatly accelerated the rate of progress. For example, Herty was not the first to observe the relationship between the CaO/SiO_2 ratio of the slag and its FeO content, which now appears to be the most important factor of slag control in the basic open-hearth process. That the FeO content of the slag is governed by the basicity was noted earlier by Nead and Washburn.[3] However, the widespread application of this fact in present day slag control would certainly not have come so quickly without Herty's intervention, and the general awareness among metallurgists in the physical chemistry of steel making, which his research work has brought about.

During Herty's eight years with the Bureau of Mines and the Metallurgical Advisory Board, and to a large extent as a result of that work, the foundation for an understanding of the chemistry of steel making has been laid, very much as 25 years earlier, Howe and Sauveur and the rest laid the ground work in the metallography of steel. This would be evident if someone were to write a new text book on the chemistry of steel making, and the group of papers under review form almost that.

The papers are closely written and no attempt will be made to abstract them in detail. Those interested will do well to obtain the originals as they comprise the clearest presentation of most of the material covered that has yet come forth. All that will be done here is to discuss some of the main points in a general way.

FeO Control in the Basic Open-Hearth Process

BEGINNING with a discussion of the refining reactions in the basic open-hearth process and the composition of open-hearth slags and interspersed with frequent recommendations as to operating details, this paper leads up to the problem of FeO control in the slag and metal. Data are presented proving the now well recognized fact that the FeO content of the slag during the finishing period is governed mainly by the basicity, the higher the CaO/SiO_2 ratio the higher being the FeO content. The type of scrap used and the degree of its oxidation during melt down appear to have a relatively minor effect, so that the comparative merits of large and fine scrap and degree of oxidation during melt down before the slag forms a cover over the bath, must henceforth be debated on other grounds

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[*] Metallurgist, Battelle Memorial Institute.

[1] Eighth Open Meeting of the Metallurgical Advisory Board, Carnegie Institute of Technology, Feb. 8, 1935.

[2] C. H. Herty, Jr., M. W. Lightner, and D. L. McBride. "The Effect of Deoxidation on the Rate of Ferrite Formation in Plain Carbon Steels." Cooperative Bulletin 64, 40 pages.

C. H. Herty, Jr., D. L. McBride, and S. O. Hough. Cooperative Bulletin 65, 56 pages.

C. H. Herty, Jr., and B. N. Daniloff. "The Effect of Deoxidation on the Aging of Mild Steels." Cooperative Bulletin 66, 52 pages.

C. H. Herty, Jr., and D. L. McBride. "The Effect of Deoxidation on the Impact Strength of Carbon Steels at Low Temperatures." Cooperative Bulletin 67, 52 pages.

C. H. Herty, Jr., C. F. Christopher, and J. F. Sanderson. "The Physical Chemistry of Steel Making. The Control of Iron Oxide in the Basic Open-Hearth Process." Cooperative Bulletin 68, 114 pages.

C. H. Herty, Jr. "The Deoxidation of Steel." Cooperative Bulletin 69, 68 pages.

[3] J. H. Nead and T. S. Washburn. Discussion at 6th Open Meeting of Metallurgical Advisory Board, Oct. 28, 1932.

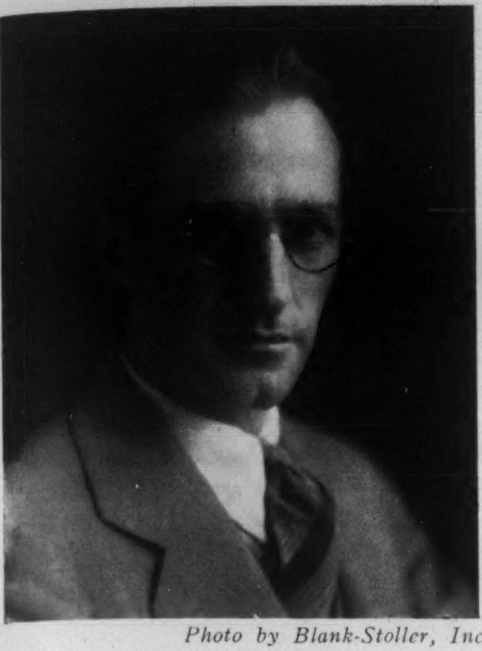

Photo by Blank-Stoller, Inc.

C. H. Herty, Jr.

In solving many of the problems involved in the broad research into the physical chemistry of steel making, Dr. Herty has been an inspiring leader. He is now a research metallurgist with the Bethlehem Steel Co., Bethlehem, Pa.

As chairman of the Metallurgical Advisory Board, Dr. Speller has been very active in promoting this extensive research. He is director of the metals research laboratory of the National Tube Co., Pittsburgh, Pa.

Frank N. Speller

than their effect on the FeO content of the slag during the finishing period.

Herty explains the relation between basicity and FeO content of the bath mainly by the viscosity. The slags with a lower CaO/SiO_2 ratio are more fluid and thus transfer the oxygen from the furnace gases to the bath more rapidly so that the FeO content is kept down. The more basic slags are more viscous, and in them the oxygen in the furnace gases, instead of being transferred rapidly to the bath, tends to build up at the top of the slag layer, raising the FeO content.

This more or less physical explanation, however, is also supplemented by a chemical one. The more basic alloys contain more excess lime over the compositions of the calcium silicates, $CaO \cdot SiO_2$ and $2\ CaO \cdot SiO_2$, and some of this excess lime forms calcium ferrite, $2\ CaO \cdot Fe_2O_3$. In this way also, the more basic slags become higher in FeO. (Herty calculates the total FeO in the slag as the FeO content + 1.35 the Fe_2O_3 content). The Fe_2O_3 bound as calcium ferrite, however, does not appear to be so active as free FeO in oxidizing the bath, and data are presented which indicate that a high FeO content in a highly basic slag will often give less oxidation of the metal bath than a lower FeO content in a more weakly basic slag. Not enough is yet known about the constitution of open-hearth slags at operating temperatures to enable us to estimate quantitatively the available and unavailable (or active and inactive) oxygen for different slag compositions and the complicating effects of temperature, viscosity, and agitation.

Purpose of Slag Control

The purpose of slag control is, of course, to regulate the degree of oxidation of the metal bath. Herty has shown that the FeO content of the bath is in general proportional to the available Feo content of the slag. However, in actual practice there is a great deal of scatter or departure from this straight line relationship, especially in the lower carbon steels in which the FeO content in bath and slag may each vary separately over a wide range in baths of nearly the same carbon content. Yet perhaps even more exacting control of the FeO content of the bath is required in the lower carbon rimming and semi-killed steels than in the higher carbon killed steels. Thus although decided benefits have already been derived from the present methods of slag control, the problem of devising test methods which will rapidly but accurately determine the oxidizing power of the slag and the degree of oxidation of the metal is still a very pressing one.

Among Herty's efforts along these lines, viscosity measurements of the slag and the "aluminum" method for determining the FeO content of the bath are described. His method of gaging the FeO content of the bath by an analysis of phosphorus content one hour after the ore addition is not applicable for low carbon steels because in these steels the phosphorus is brought down to such a low value. Whether it will prove practical for the higher carbon steels remains to be determined. The development of an effective method for low and high carbon steels along with a good method of measuring the temperature of the bath would be a great boon.

The melter must know not only the condition of his heat but also how this is tending to change, the probable rate of change, and how best to bring about desired changes. Here these studies of the effects of temperature, viscosity of the slag, and bath and slag composition have proved helpful. Herty has been very skillful in formulating a rationale for many of the rules of thumb in steel making and has thus gained more ready acceptance of his recommendations. For example, he shows that after the carbon content of the bath has been lowered to 0.10 per cent the FeO content of the slag tends to build up very rapidly. He then recommends that if a low FeO slag is desired, no time should be lost in getting the heat out of the furnace once the desired carbon is reached, while if a higher FeO slag is sought, extra time at the end of the heat should be given. A reboil with spiegel enables one to take the time to adjust the FeO content of the slag and the temperature, after the desired carbon has been reached, without unduly raising the FeO content of the metal.

For higher carbon steel the available evidence seems to indicate that working with a lower FeO in the slag gives a greater ingot yield, a saving in manganese consumption, and in general a cleaner steel. On the last point Herty believes that a too low FeO content may sometimes give a dirty steel because of insufficient FeO to flux the silicon added as deoxidizer. Thus a cleaner steel may perhaps be obtainable with the medium FeO content than with a low FeO content.

How to Get a Low FeO Slag

To get a low FeO slag the basicity may, of course, be adjusted either by lowering the lime in the charge or by raising the silicon content of the charge—or else by adding sand to the slag. It seems to be the more general practice to reduce the lime in the charge, for this purpose. Herty mentions that the limiting factor here is to avoid cutting of the furnace banks and bottom, and does not appear to consider any other possible ill effects of reducing the lime in the charge, aside from a possible rise in the phospherous content.

Reinartz[4], however, has stated that it is not advisable, in remaining steel, to lower the lime charged too much, but that enough lime must be used to give the bath a sufficient slag coverage to protect the bath from excessive oxidation from the flame. Since a low basicity would eventually lead to a low FeO in the slag rather than a high FeO, the alleged difficulties from insufficient lime to give good bath coverage may arise from a different cause than excessive oxidation. The FeO content of the bath may have been too low, in fact. However, a heavier basic slag high in FeO may protect the bath against hydrogen absorption.

The possible effects of other gases than oxygen, particularly hydrogen, is a phase of steel melting not dealt with by Herty in the papers under review. As is well brought out, however in Schenck's recent book[5], hydrogen forms a very appreciable proportion of the gases given off by Bessemer, open-hearth, and electric furnace steel, either rimming or killed, so that it may be well worth while to consider slag coverage and type of slag from the standpoint of avoiding hydrogen absorption.

The paper ends with a brief discussion of the $C + FeO = CO + Fe$ reaction, as this applies during the solidification of rimming and semi-killed steels and to "action of steel" in the mold, in general. CO evolution in the mold is affected by the ferrostatic pressure of the steel and this is considered to be the reason why in rimming steel the skin blowholes usually form in the lower half of the ingot. Here gas evolution is held back to a later stage because of the greater ferrostatic pressure, so that the gas is not swept out but is entrapped—forming skin blowholes.

The FeO content of the metal must, of course, be very finely adjusted to get the most favorable rimming action. Too high FeO will give no surface blowholes in the top half (because the gas clears itself) but deep seated primary and secondary blowholes in the bottom half. Such an ingot is usually of the falling or "shoed in" type and the steel may give inner laminations or blisters. Too low FeO in the metal may give numerous surface blowholes (because the gas cannot clear itself) extending from the bottom to the top of the ingot. Such an ingot is usually somewhat rising in type and the steel may give poor surface. Of course the carbon content is also an important factor. Herasymenko and Valenta[6] have recently shown in a very interesting discussion that a lower carbon steel may be killed more readily than a higher carbon steel. On the whole the rimming and semi-killed steels probably present a more difficult problem in slag control than do the killed steels.

Herty considers that aluminum controls the rimming action not through deoxidation alone since not enough aluminum is generally used to reduce the FeO content of the metal appreciably. He says that the action of aluminium is to regulate the release of CO from the metal through the effect of suspended particles formed, rather than to alter the rate of formation of CO by changing the FeO content. If this is true, the release of CO in rimming steel would be accompanied by the release of hydrogen. In killed steel this means of promoting hydrogen evolution would be absent.

Deoxidation of Steel

THE capital difficulty in the deoxidation of steel is getting rid of the oxide products. Carbon would appear to be the ideal deoxidizer since its oxide CO is a gas. If this were only to escape entirely from the bath, there would remain a clean and soundly solidifying steel. However, at atmospheric pressure this does not occur. It might occur if the pressure were reduced by evacuation, but making open-hearth steel under vacuum is still, of course, beyond the realm of practical possibility.

To obtain steel which will solidify quietly in the mold, deoxidizers other than carbon must be used; and these form liquid or solid deoxidation products.

To be able to get rid of such oxide inclusions, they should be as fluid as possible at steel-making temperatures so that they can readily coalesce to large particles which will float up to the slag. Herty has tried, therefore, to devise deoxidizers and a deoxidation practice which will give as fluid deoxidation products as possible. The trouble is that only strong deoxidizers will thoroughly quiet the steel, and these in general leave refractory or viscous deoxidation products. Commercially, silicon and aluminum are the two main deoxidizers which will thoroughly quiet the steel; they both form very refractory deoxidation products, SiO_2 and Al_2O_3.

It would be well if other *strong* deoxidizers were available whose oxides would tend to flux either SiO_2 or Al_2O_3. Calcium would seem to be such a one, since it is very strong deoxidizer and its oxide CaO forms the very fusible compound $CaO : SiO_2$. The disability of calcium is that it does not go into solution in the steel and thus cannot very well combine with the oxygen in it. Active attempts are still being made to develop calcium as a deoxidizer[7], but at present main reliance for fluxing agents must be placed on FeO itself, and on the very *weak* deoxidizer manganese.

SiO_2 is fluxed by FeO and MnO to give fairly fluid silicates.* Of course, too much FeO cannot be left in the steel for fluxing purposes as this would increase the burden of deoxidation and the amount of deoxidation products which have to be eliminated. In the presence of the stronger deoxidizer silicon, which tends to reduce MnO, a large preponderance of manganese must be added along with the silicon to form amounts of MnO adequate to have an appreciable fluxing action on the SiO_2.

Ratio of Manganese to Silicon

In commercial practice Herty has found that the ratio of manganese to silicon added should be at least 4 to 1. This is the basis for the double deoxidizer, silico-manganese, and Herty's recommended deoxidation practice. After adding the deoxidizer, time must be given for the oxides to form and float out; concurrently the bath is becoming reoxidized, so that the heat must be tapped at the most favorable moment. Herty recommends tapping the heat 10 to 15 min. after adding silico-manganese. The effect of temperature is to increase the fluidity so that the inclusions can float out more quickly, but at the same time it increases the amount of FeO dissolved in the metal and weakens the dioxidizing effect of the silicon. A balance must, therefore, be struck between these factors.

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[4] Reinartz, L. F. "Slag Control in Rimming Steel." Slag Control Symposium. A.I.M.M.E. October 1934.

[5] Schenck, H. "Physical Chemistry of Steel Making." Vol. 2. Julius Springer, Berlin 1934, p. 235.

[6] Herasymenko, P. and E. Valenta. "Some Problems of the Physical Chemistry of Steel Making." *Trans.* A.F.A., Vol. 5, Dec. 1934, pp. 21-47.

[7] Schwarz, C. "Killing Steel with Calcium Silicide." *Stahl und Eisen*, Vol. 53, 1933, pp. 1000-1003.

*Al_2O_3 can also be fluxed somewhat in this way to produce a fusible product that will coalesce and float up to the slag, but not very effectively when appreciable amounts of aluminum are used.

The mode of attack of fluxing and levitating the inclusions thus has obvious limitations. This is further strikingly revealed in the fact that the inclusions are much smaller in small ingots, such as ladle test ingots, than in large commercial ingots. Sims[8] has inferred from this that a considerable proportion of the deoxidation products in killed liquid steel is in solution and can only precipitate out at a slow rate of solidification as in large ingots. The more likely explanation seems to be, however, that the deoxidation products are present in a very fine state of suspension (as well as in solution), and are gathered together and coalesced during solidification into the interstices between the dendrites. In small ingots the dendrites are small and the inclusions, therefore, remain small. In large ingots the dendrites are large and the inclusions are gathered together and coalesced into comparatively large masses.

Tapping an Open-Hearth Heat

In a way it is immaterial whether the inclusions in the liquid steel are in very fine suspension or in solution. In either case they would not be removable by the method of levitation. This would set a definite limit beyond which the oxide inclusions in steel can hardly be lowered. Thus a certain minimum amount of medium sized oxide inclusions would have to be present in open-hearth steel and for that matter in electric steel. This minimum amount may not be appreciably below that customarily found in "commercially clean" steel. It may be stated that there is no evidence that the inclusions normally present in a reasonably uniform state of distribution as in commercially clean steel, do any noticeable harm to the properties for the great majority of the uses of steel.

So much for the medium sized comparatively harmless inclusions. From the foregoing one might guess that the main source of larger harmful inclusions is in the use of too strong a deoxidizer, giving rise to viscous or solid deoxidation products. In a measure this is true. However, Herty shows in very striking fashion that steels more *strongly deoxidized* in the furnace were cleaner and freer of defects which are associated with larger inclusions such as laminations and seams which appear near the surface of large axles, than steels less strongly deoxidized in the furnace. The explanation obviously lies in the effect of "action in the mold" which may occur in incompletely deoxidized steel. Gasiness or action in the mold is invariably accompanied by local segregation of inclusions into large masses. In borderline cases action in the mold is very apt to be confined to the surface of the ingot. The necessary remedy of more thorough deoxidation may be more or less simply applied in the case of fully killed hot-topped steel. In steel which is not hot-topped and in which excessive piping must be avoided, eliminating seams and laminations at the same time becomes almost a hair trigger control proposition.

Determining the Inclusion Content

Accurate quantitative methods of determining the inclusion content are essential for ascertaining the effects of variations in furnace and deoxidation practice. The available methods of electrolytic extraction of inclusions and microscopic inclusion counts have now proved their reliability for this purpose. The chemical method is most valuable for determining the actual amount and composition of the inclusions and hence their origin, and the microscopic method for determining their size and distribution and hence their probable harmful effect in the material in question.

A major difficulty in studies of open-hearth practice is the large size of the heats which tends to discourage the use of the direct and seemingly more costly experimental method. As a result the statistical method has been resorted to largely, but on account of the many variables involved, the results have seldom been very positive. This applies not only to steel cleanliness which in many products is of minor importance, but to such imperfections as poor surface, for example, which daily forces steel plants to expend excessive sums in shipping costs. With respect to such defects, much still remains to be done in developing reliable quantitative methods for comparing different heats. However, it is safe to say that as a result of the technique and expert knowledge developed during Herty's work, systematic and precise studies of furnace, deoxidation, and casting practice, (studying inasmuch as possible only one variable at a time) should accomplish as much in the next few years in improving the quality and uniformity of steel and its suitability for specific uses, as ever before.

Grain Size and Aging

SO FAR, little was said about aluminum as a deoxidizer. As is fully discussed in the bulletins 64-67 under review, the use of aluminum or similar strong deoxidizer may cause the formation of finely divided submicroscopic particles which in turn cause the steel to have an inherently fine grain. When associated with proper slag control and deoxidization practice (for the purpose of deoxidizing the steel as much as possible before adding the aluminum) the moderate aluminum addition required to give fine grain does not contaminate the steel. The aluminum may also fix the oxygen and nitrogen in the steel so that they do not give rise to precipitation effects and the steel thus becomes non-aging.

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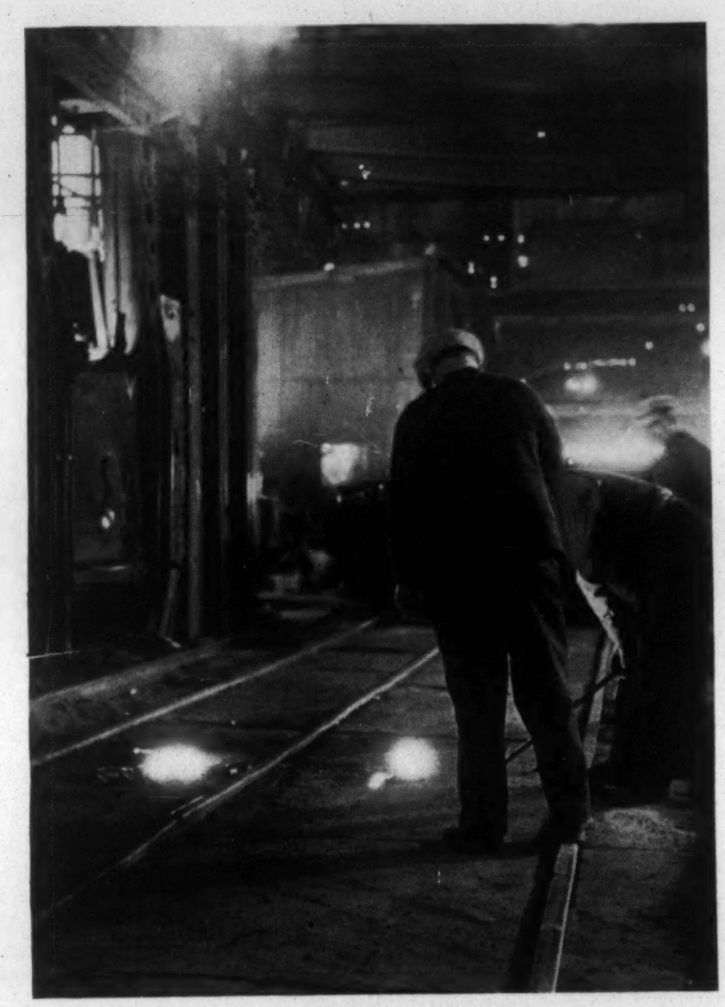
[8] Sims, C. E., and A. Lilliequist. "Inclusions—Their Effect, Solubility and Control in Cast Steel." *Trans.* A.I.M.E. Iron and Steel Div., Vol. 100, 1932, pp. 154-195.



Sampling Steel from the Open-Hearth Bath

Herty was among the foremost in showing that strong deoxidation produces fine grain and non-aging characteristics. In these papers he has also gone beyond his special field of the chemistry of steel making and made some interesting contributions to the metallography of the fine grained and non-aging steels.

Two outstanding characteristics of the fine grained steels are their lower hardenability and higher impact resistance. The lower hardenability arises from the fact that fine grained austenite transforms more readily on cooling through the critical range than coarse grained austenite. This is because the transformation begins at the grain boundaries, or rather at the grain surfaces, and can thus proceed more rapidly to completion in fine grained steels. Of course the more readily the transformation proceeds, the more difficult it is to suppress it, as is necessary to do in order to get hardening.

Herty observed that as a result of the faster rate of transformation of the finer grained steels, a low carbon normalized fine grained steel shows more free ferrite than a similarly treated coarse grained steel of the same carbon content. He inferred from this that the presence of a greater amount of ferrite is the cause of the higher impact resistance of the fine grained steels. While this may be true to some extent, nevertheless fine grain tends of itself to greatly raise the impact resistance, irrespective of the amount of ferrite. Thus fine grained ingot iron, which is all ferrite, has much higher impact resistance than coarse grained ingot iron, and similarly as Scott[9] has very well shown recently, fine grained hardened high carbon steel, in which there is no free ferrite, also has considerably higher impact resistance than a similar coarse grained steel.

Cause of Fine Grain

An interesting speculation about the cause of fine grain is whether the submicroscopic particles which are presumed to be present act only as nuclei for crystallization or whether they also directly obstruct grain growth. Herty presents some data which indicate that when a coarse grained steel is made fine by suitable heat treatment, grain growth nevertheless ensues on subsequent heating at a faster rate than in a fine grained type of steel. While not conclusive, these data would seem to indicate that the postulated submicroscopic particles tend to obstruct grain growth as well as to act as nuclei for crystallization.

If submicroscopic alumina particles are the cause of fine grain, a certain amount of oxygen must be present in the molten steel to combine with the aluminum added. There is no difficulty on the score of insufficient oxygen in open-hearth steels, even high silicon steels containing a per cent or more silicon, since aluminum readily reduces silica; the difficulty rather is in having too much FeO which would tend to flux the alumina. Herty found that if too much aluminum was added, the steel became coarse grained, giving as an example a steel containing 0.5 per cent aluminum. The explanation probably lies, however, not in too thorough deoxidation so that insufficient oxygen is left to form submicroscopic alumina particles, but in the effect of aluminum in raising the critical point. Aluminum like phosphorus is one of the elements which forms a closed loop with iron and sharply raises the critical point. As a fine grain only forms on heating through the critical temperature, no grain refinement would occur if this is raised unduly. This case would be analogous to the steels high in phosphorus which are notorious for their coarse grain.

The higher impact properties of the fine grained steels are accompanied by a shift of the sharp drop in impact resistance which occurs in ferritic steels at slightly below atmospheric temperatures, to considerably lower temperatures. Thus, as Herty has brought out in detail, fine grained steels may not become brittle until temperatures well below 0 deg. F. are reached whereas coarse grained steels are generally very brittle at this temperature. Of course, to give high impact resistance, the steel must be not only inherently but also actually fine grained. As is now well known[10], in the ordinary as rolled condition, there is no difference in grain size between the fine and coarse grained steels and no appreciable difference in impact properties. To obtain fine grain and the accompanying advantage of toughness, therefore, even the fine grained steels must be reheated after rolling to above the critical tmperature, as in normalizing, for example. For structural shapes, such heat treatment is generally considered impractical, but that it may deserve serious consideration for some purposes is indicated by the fact that a large steel plant has tried normalizing its rails.[11] The rails are allowed to cool on the hot beds to 1000 deg. F; they are then reheated to above the critical temperature, to 1500 deg. F, and cooled on the hot beds.

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[9] Scott, H. "Factors Determining the Impact Resistance of Hardened Carbon Steels." *Trans.* A.S.M., Vol. 12, December 1934, pp. 1142-1173.

[10] Symposium on Grain Size. *Trans.* A.S.M. December 1934, pp. 861-1196.

[11] Mooney, J. R. "Can We Expect Better Rails?" *Railway Age.* Vol. 98, Jan. 12, 1935, pp. 40-42.

Aging in Mild Steels

THE paper on aging in mild steel begins with a good account of the elements which might possibly cause precipitation hardening effects in iron, in the amounts in which the elements are present in ordinary iron and steel. Carbon and nitrogen may both give rise to such effects; it does not appear that oxygen in the amounts present does so. The reason strong deoxidation, as with aluminum, gives non-aging properties probably is, therefore, that fixing the oxygen changes the behavior of carbon in the ferrite so that the carbon does not go in and out of solution; aluminum also fixes the nitrogen.

Herty has coined the two expressive terms "quench aging" and "strain aging." By the former is meant changes in hardness on aging after quenching from below A_1, say at 1200 deg. F; the latter refers to changes in hardness, but particularly in the impact resistance after cold working followed by aging at room temperature or by accelerated aging on heating to the blue heat region. Quench aging and strain aging go together. The higher impact resistance of the non-aging steels after strain aging are probably caused to a considerable extent by the fine grain of the non-aging steels. On the other hand, fine grain probably has a minor effect on quench aging. The discussion of strain aging covered in this paper points to the possibility of making a non-aging structural steel of low susceptibility to embrittlement. The subject of non-aging sheet steel on which large scale developments are already in progress[12] is not dealt with.

It is significant that the making of fine grained and non-aging steel which is so new and which seemed such a difficultly controllable thing only a short time ago is now on a regular production basis in several plants—and possibly less trouble is being experienced with these steels than with the ordinary grades of rimming and semi-killed steels. The reason probably lies in the greater difficulties inherent in controlling rimming and semi-killed steel as compared to fully killed steels. As a result, now that aluminum killed sheet steel has shown deep drawing properties equal to if not superior to rimming steel, it may well be that killed steel will come into much wider use for sheet and elsewhere than heretofore. Lowering the cost of hot-topping would be helpful here.

Other Bulletins

Two other bulletins complete the list. The Bibliography of Non-metallic Inclusions in Iron and Steel[13] covers nearly 1400 articles or books prior to 1933 including some published in that year. The entries are annotated to indicate the type of information given in the reference. This will be of great value to those wishing to delve more deeply into the subject.

The last bulletin[14] summarizes the history of the whole project, lists the 52 workers who have assisted Dr. Herty in the course of the work and gives the complete list of publications.

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[12] Hayes, A., and R. O. Griffis. "Non-Aging Iron and Steel for Deep Drawing." METALS & ALLOYS, Vol. 5, May 1934, pp. 110-112. Discussion by J. H. Nead, Oct. 1934, p. 229; Reply to discussion, pp. 229-230.

[13] McCombs, L. F., and M. Schrero (Carnegie Library, Pittsburgh, Cooperative Bulletin No. 70, 400 pages.

[14] Speller, F. N., and J. B. Beatty. "Fourth Progress Report of the Metallurgical Advisory Board to Carnegie Institute of Technology and United States Bureau of Mines." Cooperative Bulletin No. 71, 1934, 16 pages.

More Metals and Alloys in a New Field

AN expanding market for metals and alloys of many varieties is found in the tendency of certain railroads to introduce, or at least experiment with, the streamlined articulated train. Two types of these have been constructed—the one of which the chief material is stainless steel and the other, aluminum alloys.

The illustrations show the front end of the new "Flying Yankee" while under construction, and the completed train. The main structure is of stainless steel joined by spot welding, a process developed by the E. G. Budd Mfg. Co., Philadelphia, Pa. This company built this train for the Boston & Maine and the Maine Central Railroads and furnished also the Burlington "Zephyr." The power is generated by a diesel engine, built by the Winton Engine Division of the General Motors Co. The "Flying Yankee" recently had its trial trip between Philadelphia and West Trenton and registered over 100 miles per hour to the comfort and satisfaction of over 175 guests. Smoothness of operation was a feature.

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Items of Interest

Distinguished Service Medals Awarded by Mining Institute

Three American engineers were selected by the American Institute of Mining and Metallurgical Engineers as recipients of the highest awards for distinguished service in the fields of mining and metallurgy in 1934. George C. Stone of New York received the James Douglas medal: James Mac Naughton, of Calumet, Mich., the William Lawrence Saunders medal; and Francis M. Rich, of Youngstown, Ohio, the J. E. Johnson, Jr., award. Presentations were made at the annual dinner of the American Institute of Mining and Metallurgical Engineers, Feb. 20, in the Commodore Hotel, New York.

The James Douglas medal, awarded for distinguished achievement in the field of non-ferrous metallurgy, has been awarded in other years to such outstanding engineers as William H. Bassett, Zay Jeffries, and Paul D. Merica, the recognized authorities on alloys of copper, aluminum and nickel. This year's winner has been a member of the Institute since 1880 and from 1882 to 1929, when he retired, was connected with the New Jersey Zinc Co. Mr. Stone's activities have been chiefly in chemistry and metallurgy, of zinc, to the literature of which he has been a constant contributor. Eight important patents have been granted to him.

The William Lawrence Saunders gold medal is awarded for distinguished achievement in mining. It has been awarded previously to Herbert Hoover and John Hays Hammond. This year's recipient, James Mac Naughton, accomplished notable results in the field when he made profitable the working of a mine which prior to 1930 produced more than 3,000,000 tons of ore annually from a vertical depth in excess of 5,000 feet and with a copper content of less than 1.8 per cent.

Mr. Mac Naughton is president and general manager of the Calumet & Hecla Consolidated Copper Co. and past president of the Lake Superior Mining Institute. He has also served as former treasurer and director of the American Institute of Mining and Metallurgical Engineers. He was educated at the University of Michigan and has spent most of his professional life in that State. He has had signal success in the development of the low-cost mining of iron ores.

The J. E. Johnson, Jr., award, is given annually to engineers under 35 years of age who have distinguished themselves in iron and steel work. Francis M. Rich, this year's recipient, is connected with the Republic Steel Corp., Youngstown, Ohio. He is a graduate of the University of Illinois in mechanical engineering.

Thomas Arthur Rickard of Victoria, B. C., Canada, was awarded the certificate of honorary membership in the Institute "in recognition," according to the citation, "of his outstanding achievement as a proponent and preceptor of advanced standards in technical concept and writing, and his brilliant contributions to the literature of geology, mining and metallurgy, as editor, journalist and author."

Mr. Rickard, who has been a member of the institute since 1888, combines to an unusual degree the qualities of a broad engineering background with those of journalist, editor, author and teacher of precision in the use of the English language. During his career, he has served as editor of the three leading mining magazines of the world—*The Mining Magazine* of London, The *Engineering and Mining Journal* of New York City and the *Mining and Scientific Press* of San Francisco.

Increased Use of Nickel and Nickel Alloys

With industry turning more and more towards iron-free chemicals in the production of a variety of products, a substantial increase in the use of equipment made of nickel and nickel alloys is reported from many sections of the chemical field, according to the annual sales summary of The International Nickel Co. "Producers of caustic soda and of phenol, both of which are especially susceptible to contamination by most metals, were among the most important users of nickel and nickel-clad steel during 1934," the summary reports. "Increasing demands also came from producers of alum, especially for paper making, another field in which protection against iron contamination is essential. One of the largest manufacturers in this field employs Monel metal for crystallizers, agitators, conveyors, chutes and centrifuges. Another has found nickel-clad steel particularly satisfactory for floor molds on which blocks of alum are cast."

American Foundrymen Select Toronto for 1935 Convention

The American Foundrymen's Association announce the selection of Toronto, the largest foundry center in the Dominion of Canada, as the place of the 1935 convention of the Association. The dates will be Aug. 19 to 23, inclusive.

This meeting, which will be held without an exhibit, will be patterned after the successful technical meeting held in Chicago at the Edgewater Beach Hotel in 1927, pleasantly remembered by all who attended. The entire program will be devoted to technical sessions, shop courses, round table discussions, committee meetings, plant visits, and the numerous social functions that add so much to the enjoyment of Convention Week.

In selecting the week of Aug. 19 for the annual convention, the Board of Directors of the Association intentionally has made it possible for foundrymen to combine attendance at the outstanding event of the year for the foundry industry with the wonderful vacation facilities offered in Canada.

The closing of the convention on Friday noon will coincide with the opening of the Canadian National Exposition, an internationally known fair held each summer. Special features will be provided for the visiting foundrymen on Friday afternoon and evening.

The Royal York, said to be the largest hotel in the British Empire, offers unusual facilities for every feature of convention activity. The committee has secured a flat rate of $4.00 for single rooms and $7.00 for double rooms. Reservations can be made for rooms for Convention Week by addressing the Convention Manager of the Royal York Hotel.

Foundrymen Organize.

A committee of Canadian foundrymen, headed by L. L. Anthes, Anthes Foundry, Ltd., Toronto, and a past president of the A. F. A., as general chairman, now is being organized to cooperate with the Association in staging the first convention of the Association in Canada since 1908.

Cost of Steel

To the Editor: Under "Editorial Comment" in the January issue of METALS & ALLOYS, Dr. Gillett says, in agreement with Dr. Johnston, that the cost of steel resides largely in the cost of raw materials rather than conversion costs, so that not much can be done in the way of lowering finished steel prices.

So far as I know, the cost of a ton of iron in the form of ore, delivered to most steel plants in this country, lies around $8.00. Since steel is around 99 per cent iron, it seems to me there is quite a spread between this figure and the current price of semi-finished steel of around $30 to $35 per ton. Even adding the cost of a ton of coke at $5.00, and 50c worth of manganese, there is still quite a lot of room for improvement.

CHAS. F. RAMSEYER.

Chicago, Ill.

A new building, 20 by 74 ft., is being added to the plant of the Wesley Steel Treating Co., Milwaukee, Wis. It will house a continuous pusher furnace which, with its operating mechanism, will take up most of the 74 ft. space. The addition, one-story high, will be made to the company's No. 2 plant. New processing units were recently added to its No. 1 plant, among them being a new Chapmanizing unit. Charles Wesley, Sr., was recently elected president and general manager for the twentieth consecutive time.

Position Wanted: A young man, 21, Harvard 1934, fair stenographer and typist, excellent knowledge of French and Spanish, is seeking a position preferably in Greater New York. Salary of secondary importance. Box No. 11, METALS & ALLOYS.

1. ORE CONCENTRATION

JOHN ATTWOOD, SECTION EDITOR

Gold Ore from the Michael-Boyle Property, Alden, Algoma District, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 25-29. Blanket concentration recovered 73-80% of the Au; amalgamation 94.9%; flotation 93-96%, of which 83% can be amalgamated; blanket concentration plus flotation gives 98.8-99.3% recovery. A flow sheet is suggested. AHE (1)

Mill Tailings from Bussières Mining Company, Ltd., Senneterre, Quebec. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 71-73. Au recoveries from a mill tailing assaying Au 0.097 oz./ton and Cu 0.095% were as follows: tabling 60, flotation 90, flotation and amalgamation 71.4 and cyanidation 90%. AHE (1)

Observations From a Study Trip to the Gold Mines in Siebenbürgen, Roumania (Anteckningar fraan en studie resa till guld gruvorna i Siebenbürgen, Rumania). Edvard Norström. *Teknisk Tidskrift,* Vol. 64, (Section *Bergsvetenskap*) Oct. 13, 1934, pages 73-78; Nov. 10, 1934, pages 83-88; Dec. 8, 1934, pages 89-94. Ore crushed in stamp mills with 360 and 610 kg. stamps. High-grade free-milling ore is amalgamated directly in small ball mills. Stamps are followed by amalgamation plates. After amalgamation the material is treated in hydraulic classifiers and on concentration tables, to produce a pyritic concentrate which is treated directly by cyanidation, without preliminary roasting. Precipitation of gold is done in boxes with zinc shavings. Chemical consumption in the process is as follows: 0.6 kg. sodium cyanide, 0.1 kg. zinc shavings, and 0.007 kg. lead acetate per ton of ore treated. A flotation plant with a daily capacity of 70 metric tons of ore has been built. Here a concentrate containing 100 g. Au per ton is produced in mineral separation cells. BHS (1)

1a. Crushing, Grinding & Plant Handling

Improvement in Milling in the Southeast Missouri Lead District. Thomas J. Clifford. *Mining & Metallurgy,* Vol. 15, Apr. 1934, pages 167-168. Abstract of paper presented at the annual meeting of the American Institute of Mining & Metallurgical Engineers. Outlines developments in methods and machinery from 1926 to 1932. VSP (1a)

Grinding of Iron Ore in Tube Mills of One or More Compartments (Om finmalning av järnmalmer särskilt i en- och fler-kammarrörkvarnar). Gust. G. Bring. *Jernkontorets Annaler—Tekniska Diskussionsmötet,* Vol. 114, May 26, 1934, pages 136-255. Part I (pages 136-171) is a historical resume of developments in grinding since 1900. Part II (pages 171-215) is an experimental study of various factors influencing the grinding process. It is shown that the capacity of a mill is directly proportional to the speed of rotation up to a certain critical value, but the energy per ton of charge shows some increase. The critical r.p.m. is theoretically shown to be $43.3/\sqrt{D}$ where D is the diameter in meters but the numerical factor was shown to vary from 40 to 80. Factors which increase the pressure of the charge against the walls or the friction within the charge lower the critical r.p.m. Increase of the pebble mass from 20%-40% increases capacity almost proportionally. Increase of the charge lowers the energy requirements but also reduces the capacity. By going from stone to steel balls the capacity is increased 3-4 times under otherwise identical conditions. The power requirements showed some increase, but the overall economy was still greater with steel balls. Cubical pebbles appeared to be the most efficient shapes. Pulp water contents up to 50% were found feasible. Occasionally capacities can be increased by varying the ratio of charge to pebbles, but in general 40% by volume of pebbles is found most effective. In general, the factors which increase the capacity of a mill will also tend to increase the power requirements. Part III (pages 215-255) deals with comparative runs on a one and a three compartment mill. The 3 compartment mill with steel balls was found to have 70% more capacity than a one compartment mill with stone balls and requiring 43% more power. If the power on the 3 compartment mill is increased 225% and charged with 40% steel balls it gives 3 times the capacity of a single compartment mill charged to the same capacity with stone balls. The better results from the multi-compartment mill appears to be due to avoiding segregation of the large pebbles near the discharge end where they will be grinding the finer rather than the coarser particles. New and evenly sized pebbles are less effective than well worn pebbles. Scrap iron can be substituted for pebbles with some advantage as to cost. HCD (1a)

1c. Flotation

Comments on Flotation—Cyanide Practice at Kirkland Lake. J. H. Heginbotham. *Mining & Metallurgy,* Vol. 15, May 1934, pages 219-220. From a paper read before the Utah section of the American Institute of Mining and Metallurgical Engineers. The question of using flotation in flowsheet for extracting Au by cyanide solutions is still debatable and it is likely to be governed by local conditions according to author. Cites practice in Kirkland Lake region. VSP (1c)

Gold Ore from the Cochenour-Willans Property at Red Lake, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 12-24. Five lots of ore containing Au 0.29-0.59 oz., Ag 0.02-0.15 oz./ton, Fe 3.45-7.25% and As 0.23-1.40% were tested thoroughly. The ore cannot be treated successfully by amalgamation nor cyanidation, nor any combination of them. Flotation of —200 mesh material gave 84-90% recovery. A flow sheet is suggested. AHE (1c)

1e. Amalgamation, Cyanidation & Leaching

Leaching Copper Ores: Study of Oxidation of Iron Solutions Used as a Solvent. Edward K. Pryor, J. D. Sullivan & G. L. Oldright. *Progress Reports—Metallurgical Division. 3. Studies in the Metallurgy of Copper. United States Bureau of Mines, Report of Investigations* No. 3228, May 1934, pages 23-31. Oxidation of Fe solutions when trickled over granular material so that they come in contact with air is inappreciable in the time usually allotted to confined leaching. Even under the most favorable conditions with O_2 flowing countercurrent to the solution, the amount of Fe oxidized was exceedingly small. H_2SO_4 and some $Fe_2(SO_4)_3$ can be prepared by trickling solutions downward through granular matter against ascending mixtures of SO_2 and air (such as smelter gas), probably more rapidly than by the older Bureau process. AHE (1e)

Magnesium Metal from Washington Magnesite and Dolomite Deposits. Carl F. Floe. *State College of Washington, Metallurgical Research Bureau, Bulletin* No. B, Mar. 1934, 21 pages. Processes for production of Mg from magnesite or dolomite are of 3 types: (1) Production of $MgCl_2$ followed by electrolysis, (2) Production of MgO followed by reduction and (3) vaporization and condensation of Mg after reduction in an electric furnace. The processes in each group are reviewed briefly. New methods are developed for production of high purity MgO or $MgCl_2$ by leaching impure magnesite with H_2SO_4 or HCl. A high extraction is obtained readily. Flow sheets are given. H_2SO_4 and HCl are regenerated. Mg can be produced from the resulting MgO or $MgCl_2$ by the electrolytic greatly but is not essential. Leaching of high-grade dolomite by similar methods process. Calcining the magnesite prior to leaching increases the rate of extraction is practical. Fe is removed by neutralization of all acid and precipitation with excess calcine. SiO_2 remains insoluble. Ca is removed as the insoluble sulphate. Over 50 references to articles and 104 to patents. AHE (1e)

The Physics of Gold Solution. J. A. White. *Journal of the Chemical, Metallurgical & Mining Society of South Africa,* Vol. 35, July 1, 1934, pages 1-11. The author discusses the theory that the rate of solution of Au in cyanide solutions is dependent mainly upon the diffusion of O. The conclusions from a physical and mathematical consideration are applied to experimental results. AHE (1e)

Experimental Tests on Gold-Bearing Sulphides from Placer Deposits in the Cariboo District of British Columbia. C. S. Parsons, A. K. Anderson, J. D. Johnston & W. S. Jenkins. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 13-15. Drill cores were washed and tabled. Free Au was removed from the concentrate by panning. The sulphides were chiefly pyrite and pyrrhotite. Amalgamation of material ground to 80-85% through 200 mesh gave 97% extraction. Addition of CaO did not improve results. Coarser grinding lowered extraction. Cyanidation gave lower extraction (average 92.4%) and CaO consumption was 23 lbs./ton. AHE (1e)

The Hydrometallurgy of the Base-metals and Its Application to Canada. Richard W. Herzer. *Transactions Canadian Institute of Mining & Metallurgy,* 1934 (in Canadian Mining & Metallurgical Bulletin No. 271, Nov.) pages 521-544. Present hydrometallurgical processes for Pb and Zn treatment are discussed briefly. Cu leaching is described at length, including reagents, treatment for different types of ores and the recovery of precious metals. Conclusion: Leaching offers no serious competition to concentration and smelting at present. AHE (1e)

Gold Ore from Halcrow-Swayze Mines, Limited, in Halcrow Township, Ontario. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 63-66. A pyrite-chalcopyrite-Au ore containing Au 0.245 oz. and Ag 0.053 oz./ton was cyanided with good recoveries. Amalgamation gave only up to 55% recovery. Concentration gave high value tailings. AHE (1e)

Gold Ore from Kootenay Belle Mine, Salmo, British Columbia. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 74-76. An ore assaying Au 2.12 oz., Ag 0.59 oz./ton, Pb nil, Zn trace, and Cu 0.01% cyanided readily to give a high recovery and a 0.04-oz. tailing. Flotation and tabling show a lower recovery and a 0.10-oz. tailing. AHE (1e)

Regeneration of Ferric Sulphate in Copper-Leaching Solutions. W. A. Sloan & A. F. Hallett. *Progress Reports—Metallurgical Division. 3. Studies in the Metallurgy of Copper. United States Bureau of Mines, Report of Investigations* No. 3228, May 1934, pages 33-35. In the small tower (1-3/8 in. x 5 ft.) used for regeneration, -10 + 20 to -10 + 28 mesh packing gave best results. No accelerators were found. The maximum attainable capacity is 250-300 gals. of regenerated leaching liquor/day/sq. ft. of tower area. AHE (1e)

Tests on Gold Ore from Mining Claims K-3645, Island 102P, Lake of the Woods District, Ont. C. S. Parsons, A. K. Anderson, J. D. Johnston & W. S. Jenkins. *Canadian Department of Mines, Mines Branch Report* 736, 1934, pages 109-116. Most of the Au can be recovered by amalgamation (90%) or by blanket concentration followed by barrel amalgamation of the blanket concentrates (94.47%). Concentration of the tailings by flotation raises recovery. AHE (1e)

Profitable Tailings Retreatment. *Chemical Engineering & Mining Review,* Vol. 27, Oct. 8, 1934, pages 12-13. A description of the plant at Ida H mine in West Australia. Before treatment all the Au slime is ploughed, rolled and harrowed. There are 12 leaching vats each with a capacity of 35 tons—treatment rate being 70 tons daily. Details of the cyanide plant are given. WHB (1e)

Gold Ore from Cranberry Head, Yarmouth County, Nova Scotia. *Canadian Department of Mines, Mines Branch Report* No. 743, 1934, pages 4-11. Au recovery from an ore containing 1.50 oz. Au/ton was more than 95% by cyanidation or amalgamation followed by flotation of the tailing. Flow sheets are suggested. AHE (1e)

2. ORE REDUCTION

A. H. EMERY, SECTION EDITOR

Importance of Chemical Equilibrium Studies in Metallurgical Processes (Den kemiska jämviktslärans betydelse för de metallurgiska processerna). Bo. Kalling. *Jernkontorets Annaler-Tekniska Diskussionsmötet,* Vol. 114, May 26, 1934, pages 69-135. Principles, rather than new data, are presented. Numerous equilibrium diagrams bearing on ore reduction, carburization, acidity of slags, removal of impurities, Bessemer steel and deoxidation are given and discussed. Practical metallurgists will find helpful the methods of applying data to plant problems. Since so many of the equilibria involve liquid or solid solutions, equilibria cannot be predicted quantitatively as with gaseous systems. In metallurgy, thermodynamics is chiefly valuable for systematizing information. HCD (2)

2a. Non-Ferrous

Production of Pure, Finely Powdered Vanadium (Die Darstellung reinen, feinpulvrigen Vanadiums). Theodor Döring & Johannes Geiler. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 22, Dec. 11, 1934, pages 56-62. A dry mixture of VO_5 and S was chlorinated, forming $VOCl_3$ and VCl_4. Heating converted this to VCl_3 and excess S was dissolved out with CS_2. The VCl_3 was reduced with H at 900° C. to form a very fine, light gray metallic powder free from impurities, especially O, N, H. WB (2a)

Copper Reduction. A. B. Young. *Mining & Metallurgy,* Vol. 15, Jan. 1934, pages 24-25. Much attention is being paid to flash roasting, refining and re-forming scrap and waste materials. The outstanding development has been the perfecting of manufacture and extension of the use of thin electro-deposited Cu sheets. Development in use of Cu for pipe and fittings is progressing. VSP (2a)

Metallurgy of Lead. Carle R. Hayward. *Mining & Metallurgy,* Vol. 15, Jan. 1934, pages 22-23 Pb smelters operating at reduced capacity and secondary Pb assumed more importance in 1933. Improvements were more noticeable in refining than in smelting. The outstanding event of 1933 was the opening of the new Parkes process refinery at Midvale, Utah. Some of the new features of this refinery are discussed, including Hulst method for decopperizing drossed Pb, a novel method of skimming and handling dross and continuous softening and desilverizing. The Betterton method for removing Bi by using Ca and Mg was installed at the plant of the American Smelting & Refining Co., Omaha. Antimonial Pb from storage batteries has had a favorable market. VSP (2a)

Fundamentals of Aluminum Electrolysis (Grundzüge der Aluminiumelektrolyse). H. Ruderer. *Berg- und Hüttenmännisches Jahrbuch,* Vol. 82, Sept. 28, 1934, pages 105-109. Al production by the Hall-Héroult fusion electrolysis is described. Economy of electrical energy from hydro as compared with steam power stations, most favorable locations of Al plants, furnaces and electrochemistry of the process are discussed. Ha (2a)

2b. Ferrous

The Granulation Method at Bochum with Special Reference to the Utilization of the Water for Health Baths (Das Granulationsverfahren des Bochumer Vereins unter besonderer Berücksichtigung der planmässigen und gesundheitsspendenden Wasserwirtschaft). J. Stoecker. *Stahl und Eisen,* Vol. 54, Nov. 1, 1934, pages 1129-1132. With proper care blast furnace slag can be granulated so that all the H_2S formed is dissolved in the water and does not become a nuisance. The water is suitable for health baths. SE (2b)

Blast Furnace Problems. W. McConnachie. *Blast Furnace & Steel Plant,* Vol. 22, Oct. 1934, pages 567-571. Some of the crude Fe produced in the higher levels of the furnace is reoxidized by the hot blast. Oxides thus formed are reduced very rapidly in the space below the tuyères by alkali vapor produced at or near the surface of the slag. Alkaline oxides formed by reduction of FeO are in turn reduced by the C on or in the slag. Alkalis thus undergo repeated oxidation and reduction. When the primary slags contain silicates that can be decomposed by the alkaline oxides, the amount of K and Na in circulation becomes smaller and smaller. It is this interference with the circulation of the alkalis that makes dirty Fe-bearing slags. Charging should be so arranged that the least possible amount of molten crude Fe will be exposed to the hot blast, and the blast distribution should be so arranged that the extra rich reducing gases formed below tuyère level can rise in the furnace with the least possible interference from the blast stream. Keeping the number of tuyères as low as possible and "overhanging" them as much as possible will help considerably. MS (2b)

Modern Swedish Blast Furnace Practice (Nutida svensk masugnsdrift). Magnus Tigerschiöld. *Jernkontorets Annaler Tekniska Diskussionsmötet,* Vol. 114, May 26, 1934, pages 8-68. Charcoal is usually stored and transported to avoid excess moisture. Screening removes dust and provides uniform sizes. Roasting of ores has made much progress because it removes S and causes smoother operation. Several of the roasting processes and various types of improved furnace construction are discussed. Several heat balances and operating results in various plants are given. The chief factors in reducing charcoal consumption are (1) use of easily reduced charges, (2) uniform distribution of ore and fuel, (3) lengthening of the flue to conserve heat, (4) avoidance of forced operation and (5) increase of blasting temperatures. Considerable effort is being made to develop uses for slag in bricks, refractories, or other constructional materials. HCD (2b)

Burning of Tuyères in Blast Furnaces. N. L. Goldstein. *Domez,* No. 2-3, 1934, pages 22-37. In Russian. Average life of tuyères in 4 South Russian blast furnace plants was 85-746 hours. Tuyères failed by burning, due to mechanical defects, and by abrasion. The burning occurred almost exclusively at the nozzle of the tuyères. Top burning is caused by molten metal or high Fe slags impinging on the upper surface of the tuyères. Bottom burning is caused by the rising of metal level in the hearth. Liquid Fe and slag collect in the cavities formed by the burning of coke. which is fastest in the oxidizing zones before the tuyères. The greater the area of the horizontal projection of the oxidizing zones and the greater the volume of these wells, the less chance for bottom burning will be encountered. A greater amount of metal passing over a tuyère might cause a greater possibility for top burning. The distribution of the burden plays a pronounced role. These observations were checked on a number of blast furnaces of these plants. (2b)

On the Effect of the Blast Temperature in Blast Furnace Smelting of Sintered Charges (Naagot on Blästertemperaturens Betydelse vid Sinterbeskickade Masugnar). Helmer Nathorst. *Teknisk Tidskrift,* Vol. 64, Aug. 11, 1934 (Section *Berasvetenskab*) pages 57-62. Paper presented before the Swedish Society of Chemistry and Mining, April 5, 1934. Average blast temperature used at Fagersta Iron Works in producing a basic Fe from charges consisting of 100% sinter was 386° C. during the tests and the average temperature of the furnace gases was 143° C. There was only a very slight improvement in the operation from raising blast temperature. Betterment in $CO:CO_2$ ratio offers the best chances of real improvement of the process. BHS (2b)

Sponge Iron from Pyrite Cinder. V. Shmelov. *Stal,* Vol. 4, Apr. 1934, pages 51-54. Residues from pyrite roasting containing 4.39% S were reduced by a mixture of CO and H to sponge Fe containing 80% metallic Fe and 0.25-0.30% S. The S in the product is decreased by increasing the H ratio in the reducing gases. HWR (2b)

Standardizing the Refining Period in Making Steel. Folke W. Sundblad. *Iron Age,* Vol. 133, Jan. 25, 1934, pages 17, 70. Discusses the importance of standardizing the steel refining period and its effect on uniformity of the product. Complete standardization of a large open-hearth heat is out of the question, due to the impossibility of getting a uniform charge. Recommends sample test pieces for standards. VSP (2b)

The Krupp "Running" Process (Das Krupp-Rennverfahren). Fr. Johannsen. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Sept. 29, 1934, pages 1141-1142; *Iron & Coal Trades Review,* Vol. 129, Oct. 12, 1934, page 542. Ore containing about 25% Fe, and crushed to minus 10 mm. size, mixed with about 30% of a fine-grained fuel, cheap coal wastes, coke breeze, etc., is charged to a horizontally rotating furnace. The small particles of C-poor, slag-free Fe are mixed with gangue from which they are separated easily by crushing. The finest particles after crushing are separated magnetically and put through the furnace again. The recovery is 90-96% of the Fe. The C content of the Fe is 0.5-1.5%. A ton of sponge Fe could be produced for only 34.38 M., which is about 1/3 less than costs with ordinary blast furnace practice. Particular advantages for German conditions are pointed out. Ha (2b)

Insulated Blow Pipe. A. A. Gould. *Blast Furnace & Steel Plant,* Vol. 22, Sept. 1934, pages 513-514. A blast-furnace blowpipe has been developed. It consists of an outer tubular member welded to an end casting at the tuyère end and to a casting which engages the seat on the tuyère stock. These 3 parts take all the thrust on the blowpipe. The inside sleeve of heat-resisting alloy is welded to the end casting on the tuyère stock but forms a sliding fit in the other end to compensate for difference in expansion between the 2 sleeves. Powdered or granular insulation fills the space between the sleeves, effectively retains the heat of the blast and keeps the outer sleeve at a safe operating temperature. Tests on bare and insulated blowpipes 3 ft. 9 in. long showed a saving of 3.5 tons of coke per day for a set of 14. For the bare pipes, operating at a visible red heat and a bustle pipe temperature of 1550° F., there was an 83° F. drop in blast temperature between the 2 ends of the blowpipe. For the insulated pipe of the same size, this loss was only 10° F. MS (2b)

The Blowing of Flue Dust into the Blast Furnace According to Heskamp's Method (Das Einblasen von Gichstaub in Hochöfen nach dem Verfahren von Heskamp). O. Wehrheim. *Stahl und Eisen,* Vol. 54, Dec. 6, 1934, pages 1253-1256. In Heskamp's method flue dust is blown back into the blast furnace; this is cheaper than briquetting. The method is described and data on its successful operation are given. SE (2b)

The Phases Occurring in the Reduction of Mixtures of Iron Oxide with Several Other Oxides (Über die bei der Reduction der Mischungen von Eisenoxyd mit einigen anderen Oxyden auftretenden Phasen). Ernst Jenckel. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 220, Nov. 30, 1934, pages 377-388. The constitutional diagrams for Fe, O and a third oxide for 1 temperature and various CO_2 concentrations are given. The third oxides investigated were BiO, SiO_2, MnO, MgO, Al_2O_3, Cr_2O_3, P_2O_5, ZnO. The Fe corner of the diagrams was neglected in favor of the region of the diagram from 100% CO_2 down to the appearance of the Fe phase. WB (2b)

Solubility of Carbon in Iron Chromium-Silicon Alloys (Die Kohlenstofflöslichkeit von Eisen-Chrom-Zilizium-Legierungen). Otto Lucas & H. Wentrup. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 220, Nov. 17, 1934, pages 329-333. In 1 method, low C ferro-chrome is made by reducing chromite and quartz in an electric furnace to form a product containing 40-60 Cr, 30-40 Si, 5-10 Fe and the rest C. The Si and C are oxidized by adding chrome ore. The Si content of the final product is less than 2% and C can be entirely removed. Because of cost, C is reduced only to various consumer tolerances. C content of the alloys rises with Cr content. Addition of Si decreases C. Lowest C can be obtained at 1700° C. with 40 Cr and 30 Si. Higher Si (41.5%) at 1800° C. and 44.2% Cr allows C to go to 0.93%. Further increase in temperature allows lower C but the Si will be higher than the Cr. Curves are given showing C vs. % Si and C vs. temperature for various Si contents. WB (2b)

Utilization of Domestic Iron Ores in the Charcoal Blast Furnace (Die Nutzbarmachung inländischer Eisenerze im Holzkohlenhochofenbetrieb). B. OSANN. *Die Giesserei,* Vol. 21, Aug. 31, 1934, pages 370-373. Castings direct from the charcoal blast furnace are of very good quality because of low S and P content and particularly because of complete freedom from FeO. The pig Fe is also excellent for making steel for razor blades, etc. and for open-hearth steel. 8 references. Ha (2b)

Desulphurization Studies. T. L. JOSEPH & W. F. HOLBROOK. *Progress Reports—Metallurgical Division. 6. United States Bureau of Mines, Report of Investigations* No. 3240, June 1934, pages 13-25.—Metal containing several tenths of 1% S can be desulfurized by cooling the metal if the residual Mn approximates 2.0%. A small amount of Mn will be lost as MnS. At a given temperature % Mn x % S = K. Normal variations of Si and Mn have little effect upon K. A low-S metal and a product suitable for producing ferro Mn can be produced by treating high-P spiegel with FeS. CaO is a more active S scavenger than MgO in blast-furnace slags. The decreased desulphurizing power of the slag was very pronounced beyond 10% MgO when molar basicity was held constant. Substitution of MgO for CaO on a percentage basis $(\% \text{ CaO} + \text{MgO})/(\% \text{ SiO}_2 + \text{Al}_2\text{O}_3) = 0.91$) decreased desulphurization less than that produced by lowering the temperature 50°. AHE (2b)

The Effect on Mortar and Cement of the Sulphides in Blast Furnace Slag (Das Verhalten der Sulfide der Hochofenschlacke in Zementmörtel und Beton). H. BUCHARTZ & E. DEISS. *Archiv für das Eisenhüttenwesen,* Vol. 8, Nov. 1934, pages 181-186. Mortar and cement made with the addition of blast furnace slag are stable in the presence of water. Under experimental conditions favoring the oxidation of sulphides there was no evidence of the formation of gypsum with consequent deterioration of the cement. SE (2b)

Freezing of Iron Ores and Development of Methods for its Prevention. D. A. BROUN. *Domez,* No. 9, 1934, pages 1-15. In Russian. To 12 perfectly dry Krivoi Rog ores different amounts of H_2O were added; the ores were frozen in 25 x 40 x 60 mm. molds. These blocks were tested for strength. (See "Briquetting Fine Iron Ores for Open Hearth Furnace Use," *Metals & Alloys,* Vol. 5, page MA 553L/9). Higher clay content reduced freezing. With not more than 3% H_2O above the inert moisture, freezing is very slight, increasing sharply with each percent of moisture. In powdery ores this break is absent and a straight line relation exists. Lime, salt, straw chaff and sawdust can be recommended as efficient and economical for prevention of freezing of the ore in the cars. (2b)

Direct Production of Iron from Powdery Ores of Krivoi Rog. Z. I. NEKRASSOV & K. N. SPELTY *Domez,* No. 9, 1934, pages 16-28. In Russian. Ore (94.67% Fe_2O_3, 1.1% FeO, 3.8% SiO_2) was powdered, mixed with at least 50% anthracite and heated between 600° and 1200° C. in a muffle furnace. In 1 hour 95% reduction is reached at 980°-1000° C.; higher temperatures did not increase the reduction. Greatest reduction was obtained in a stationary atmosphere, the reduction being inversely proportional to the speed of the gas passage. An ore containing more SiO_2 (78.3% Fe_2O_3, 0.46% FeO, 18.96% SiO_2) required 1 hour at 1100°-1150° C. for 95% reduction. Between 4 and 40 mesh the difference of size does not have a pronounced influence on the speed of reduction. (2b)

New Iron and Steel Plant in South Africa (Das neue Eisen—und Stahlwerk in Südafrika). E. A. CZERMAK. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Nov. 25, 1934, page 749. Description of coke oven plant, blast furnaces, steel and rolling mills of South African Iron & Steel Industrial Corp., Pretoria. GN (2b)

Blast-Furnace Developments. A. MCCANCE. *Iron & Coal Trades Review,* Vol. 129, Dec. 21, 1934, pages 982-983. Progress in blower equipment, power units, output in relation to blast pressure and power required are reviewed. The most economical blast-furnace for Scottish conditions is one with a daily production of 200 to 400 tons. Ha (2b)

Soviet Standardizes Blast Furnace Design. GORDON FOX & OWEN R. RICE. *Iron Age,* Vol. 133, Mar. 8, 1934, pages 20-24, 58. Outlines blast furnace practice in Soviet Russia and gives particulars of furnace construction program; 5 furnaces are in operation, 9 in course of construction and 41 are projected. Government control has made possible adoption of a standard design which with slight changes may be adapted to different conditions, raw materials and product. Standard furnace is of 1000 ton capacity; furnace volume is 32,000 cu. ft. Arrangements for charging are in conformity with American practice. Each furnace is served with 3 stoves. Total heating surface per stove is 173,000 sq. ft. VSP (2b)

Petrographic Method in Slag Examination. R. GRAHAM & R. HAY. *Foundry Trade Journal,* Vol. 50, May 10, 1934, page 302. See *Metals & Alloys,* Vol. 5, Oct. 1934, page MA 471. AIK (2b)

3. MELTING, REFINING AND CASTING

Fundamental Theory Relating to the Strength of Green Molding Sands. P. P. BERG. *Reports of the Central Institute of Metals (Soobschenii Central 'Nago Instituta Metallov),* Leningrad, U. S. S. R., No. 16, 1934, pages 151-154. In Russian. The author discusses 2 theories explaining the strength of green molding sand: either green strength is due to a mechanical interlocking between irregularities of the sand grains or to the surface tension between the liquid coating each grain. In the present investigation the silica sand grains were separated from clay and tempered to different moisture contents. The typical results of sand test are given in Table 1.

TABLE 1

Diam. of sand grains mm.	Moisture %	Strength		Porosity
		Compressive	Tensile	
0.102	1.0	0.135	2.80	43.0
0.102	2.0	0.140	2.84	40.2
0.102	3.0	0.170	2.86	38.6
0.102	4.0	0.125	0.73	35.0
0.102	6.0	0.120	1.12	29.2
0.102	8.0	0.120	1.18	24.7
0.102	10.0	0.140	6.10	19.4
0.102	12.0	0.250	10.15	16.1

It may seem that there are 2 maxima of compressive and tensile strengths in relation to the moisture content. The presence of 2 maxima, the author states, indicates that there are at least 2 factors responsible for the strength of sand so that the strength values observed are the summations of the strength caused by each of these factors. The energy of the surface tension depends on the surface tension force and the surface area of liquid. Surface tension forces are: for water 71 dynes-cm., for alcohol 22 dynes-cm. and for oils 32-36 dynes-cm. The relation between the strength of sand and surface tension may be checked experimentally: sand tempered with water shows compressive strength of 0.25 kg./cm.², whereas sand tempered with alcohol has a strength of 0.08 kg./cm.²; i.e. the strength of sand tempered with alcohol is 32% of the strength of sand tempered with water. The surface tension force of the alcohol is $\frac{22 \times 100}{71} = 32\%$ of the surface tension force of water. In regard to the second factor controlling the surface tension energy; i.e. the surface area of the liquid, the author points out that the surface area of the sand grains is in inverse proportion to their diameter. The author calls attention to the fact that the thickness of the liquid layer is also to be considered and states that in order to obtain the maximum strength the moisture content should be increased with an increase of the surface area as it may be seen in Table 2.

TABLE 2

Diameter of sand grains mm.	Optimum moisture content for same strength
0.1-0.2	3%
0.074-0.1	4%
0.02-0.05	6%

No definite formulated relation between the strength of sand and grain interlocking can be established. It is known that angular grains interlock stronger than round grains. The strength of mechanical interlocking should also depend on the coefficient of internal friction of the liquid coating of the grains. AIK (3)

The Wooden Pattern Plate (Die Holzformplatte). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, pages 478-479. Transportation, storing and manipulation of pattern plates made of gypsum, cast Fe or white metal are sometimes difficult because of weight. These disadvantages are not encountered with wooden pattern plates. Preparation of such plates and special points to be observed in processing are considered. Various types of wooden pattern plates are illustrated. GN (3)

Testing of Molding and Core Sands (Die Prüfung von Form- und Kernsanden). *Die Giesserei,* Vol. 21, Nov. 23, 1934, pages 497-504. The new regulations and testing methods developed by German Committees are reproduced in full and commented on. Ha (3)

Factors Influencing the Density and Soundness of Ferrous and Non-Ferrous Castings (Quelques Facteurs qui influencent la Compacité et la Santé des Moulages d'Alliages Ferreux et Non Ferreux). E. LONGDEN. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Aug. 1934, pages 384-395; *Foundry Trade Journal,* Vol. 51, Aug. 9, 1934, pages 87-88; Aug. 23, 1934, pages 117-123. British exchange paper presented at the Nancy Foundry Congress, July 1934. Review of subject. The interval of solidification largely determines the density and soundness of cast metals. Different metal mixtures, molds and pouring conditions affect the interval of solidification. WHS + AIK (3)

Influence of Clay and Water in Oil Sand Cores (De l'Influence d'Additions Croissantes d'Argile et d'Eau sur la Propriétés de Résistance des Noyaux a l'Huile, a l'État Vert et a l'État Sec). H. NIPPER. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Aug. 1934, pages 373-382. Paper presented at the Nancy Foundry Congress, July 1934. Water additions to oil sand containing clay increase the green bond, but both water and clay additions lower the dry strength of the core. Exposure of dried cores to water lowers their strength and rebaking does not restore them to their original strength. WHS (3)

Modern American Foundry Methods (Moderne werkwijzen in Amerikaansche Gieterijen). P. L. MEURS GERKEN. *Polytechnisch Weekblad,* Vol. 28, Aug. 9, 1934, pages 497-501. Discusses and abundantly illustrates up-to-date American foundry methods. Mechanical handling of sand and furnace equipment are discussed in detail. WH (3)

Control of the Packing of Sand in Shaking Molding Machines (Controle du Serrage du Sable sur les Machines à mouler à Secousses). G. DELCROISETTE. *Revue de Fonderie Moderne,* Vol. 28, Nov. 25, 1934, pages 327-328. Apparatus is described which determines whether the sand in the mold is packed in just the manner as prescribed for the particular kind of sand used. It consists of a small disc which penetrates into the sand under its own weight by the vibrations caused in the shaking process; the depth of penetration under defined conditions is a measure of the density of the rammed sand. Ha (3)

Molding From Old Broken Castings (Das Formen nach alten gebrauchten Abgüssen). ERICH BECKER. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Dec. 9, 1934, pages 513-514. Discusses method for making mold from a broken bronze casing and gives general practical hints when molds of intricate hollow parts are to be made from broken castings. GN (3)

3a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Operations in a Completely Mechanized Foundry. T. W. LIPPERT. *Iron Age,* Vol. 134, Aug. 16, 1934, pages 10-15. Describes the mechanized brass foundry unit of the Pennsylvania Railroad at South Altoona. Gives a schematic layout of the plant. Products made include sand cast tumbler lock bushings, engine bells and driving box shells. Four types of products account for 90% of tonnage output. Journal bearings (74 Cu, 18 Pb, 6 Sn and 2 Zn) are cast in permanent molds of the Holley Type. The other product, known as engine brass (80 Cu, 10 Sn and 10 Pb), also made from scrap is poured into sand molds. The third product, a form of red brass (85 Cu, 5 Pb, 5 Zn and 5 Sn) used for casting pressure goods is cast in sand molds on continuous machines. The final product is a high-Pb piston packing material (60 Pb, 2 Ni and 38 Cu) and is melted in electric furnace by rocking the furnace. VSP (3a)

Difficulties in Processing Non-Ferrous Metal Castings (Schwierigkeiten bei der Herstellung von Metallguss). WERNER FRÖHLICH. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, pages 475-476; Dec. 9, 1934, pages 514-517. Discusses a number of examples of non-ferrous metal castings in which difficulties are frequently encountered. (1) In casting gears and similar parts of bronze, failures may be caused by the chills. According to the experience of the author the width of the chill should correspond to the width of the gear. Composition of the chill is of considerable importance. Best results were obtained with Fe chills containing a high percentage of graphite. The higher the graphite content above 3% the less the difficulties encountered. (2) In considering difficulties arising in casting thin plates of brass, bronze, Al and Al alloys author emphasizes importance of proper casting temperature, proper arrangement and dimensioning of gates and risers. In conjunction with the casting of Al alloys paper refers to the failure of cast Fe crucibles that must possess a very low P content to show high durability. For increasing durability author advises frequent washing of melting vessels or crucibles with a mixture of 70% Al_2O_3 and 30% bone ash. (3) Surface failures apparent in casting brass bars may be eliminated by applying mold coating of oil-soot-petroleum mixtures, high casting temperatures, and change of gating. Paper finally considers importance of purity of metals and alloys for obtaining sound castings and refers to difficulties arising occasionally in casting Cu. GN (3a)

Nickel-Chromium Alloys in the High-Frequency Furnace (Nickel-Chromium-legierungen im Hochfrequenzofen). F. JABLONSKY. *Technologist,* Vol. 40, Dec. 1934, pages 71-78. Ni-Cr and Cu-Cr alloys behave peculiarly when used as electric resistors in high frequency apparatus; after some time the wires split in the direction of drawing of the wire; furthermore, the elasticity of the wires is widely different in the same piece. The cause can in most instances be traced to the high-frequency furnace in which these alloys are often manufactured as this method accelerates gas absorption by the hot metal which is difficult to prevent. To obtain good wires the ingots for drawing must be very carefully annealed at proper temperatures after forging and drawing, and they should be heated to at least 1670° F. and held for some time at this temperature before forging. Correct strength of the blows will keep the blocks at the proper temperature; 1400° minimum. Additions of Ca, up to about 0.04%, 0.25% Si and 0.1% Ti are advantageous to prevent gas absorption. The problems attending manufacture of Ni-Cr alloys are discussed at length and suggestions for testing methods and equipment are given. Ha (3a)

Causes and Prevention of Metal Being Pressed out of Gates and Risers (Das Metall quillt aus dem Einguss und den Steigern (Ursachen und Verhinderung). A. HEINZ. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Oct. 28, 1934, pages 452-454. Of greatest importance is careful covering of the liquid metal. No less important is correct melting procedure, particularly in furnaces equipped with preheaters. Paper refers in particular to melting in oil fired furnaces. Proper method of deoxidation is outlined. Furthermore overheating of the melt should be guarded against to prevent rising of metal in mold. Melting time should be as short as possible. Author finally touches upon melting of Al and Al alloys and describes simple testing methods to distinguish Al alloys of various compositions. By observing all these different points rising of metal in mold can be prevented. GN (3a)

Copper Alloy Die Castings Increase Design Possibilities. ALLEN F. CLARK. *Machine Design,* Vol. 6, Nov. 1934, pages 24-26. The primary rules that apply to Zn and Al die casting should be borne in mind in specifying Cu alloy die castings. For instance minimum wall stocks in a cylindrical section should be 3/32 in.; variations for drawing dimensions ± 0.003″; desirable draft on side walls and cores = 0.02″/in.; minimum size of cored holes = ⅛″ diameter. Steel or Fe inserts may be used in Cu alloy die castings which are classified as (1) permanent mold or vacuum castings of Al bronze and (2) pressure die castings of brass. Addition of Al has been found to inhibit the oxidation in the pressure die casting process where the metal must be maintained for appreciable periods at casting temperature. Al also reduces vaporization of Zn in the holding pot and diminishes the deposit of ZnO on the die surfaces. Sn increases fluidity, inhibits segregation of Pb in the holding pot and increases the corrosion resistance of the final casting. The balance of the paper discusses at length commercial utilization of Cu alloy die castings and their physical properties. WH (3a)

Melting of a Copper-Nickel Alloy (Schmelzen einer Kupfer-Nickel-Legierung). G. SCHÜLE. *Die Giesserei,* Vol. 21, Dec. 7, 1934, pages 520-521. Ni alloys have a strong tendency to give porous castings because of their susceptibility for gas absorption. The following melting process is recommended: If an alloy of, e.g. 15% Ni, 17% Pb, 20% Zn, 3% Sn and 45% Cu is to be melted intermediate alloys of Ni, Zn and Pb should be made in the ratio 50:50; for instance if the total melt is 100 kg., at first 15 kg. Ni with 15 kg. Cu, 17 kg. Pb with 17 kg. Zn are melted; the remainder of 30 kg. Cu and 3 kg. Zn is added after these amounts have melted. The melting temperature of this alloy is about 1300° C., pouring temperature should be not less than 1200°. Rapid heating is necessary to avoid gas absorption. Melting and pouring procedure is described in detail and properties of the alloy are given. Ha (3a)

Remelting of Brass Scrap in Reverberatory Furnaces (Das Umschmelzen von Messingschrott und -abfällen in Flammöfen). KARLHEINZ HERBERT. *Die Metallbörse,* Vol. 24, Aug. 25, 1934, pages 1081-1082; Sept. 1, 1934, pages 1113-1115; Sept. 8, 1934, page 1147; Sept. 15, 1934, pages 1177-1178; Sept. 22, 1934, pages 1209-1210; Sept. 29, 1934, pages 1241-1242; Oct. 6, 1934, pages 1274-1275. Brass scrap is remelted in various types of furnaces which should primarily meet the following requirements: reasonably low losses of Zn (Sn), small absorption of atmospheric gases. The advantages of the reverberatory furnace are (1) low fuel consumption, (2) large output, (3) uniformity of remelted brass scrap. The advantages and shortcomings of other melting furnaces are discussed critically. For small quantities of scrap, oil-fired (tilting) crucible furnaces are best suited. Reverberatory furnaces are dealt with in detail referring to design, fuel, charging, selection of refractories, starting of newly built furnaces, melting operation and tapping. The 3rd chapter of the paper deals at great length with crucible and electric-furnaces utilized for remelting brass scrap. EF (3a)

Utilization of Silver Scrap (Zur Verwertung von Silberabfällen). P. KÖHRING. *Die Metallbörse,* Vol. 24, Aug. 25, 1934, pages 1082-1083; Sept. 1, 1934, page 1115. In 1925, 12,000 ounces Ag were recovered in Los Angeles from waste of the film industry. Ag was deposited on Fe sheets suspended in the Ag containing solution. Other methods are precipitation by 1) Zn or Cu (2) NaCl or NaCl solutions, and (3) HCl. The method employed is criticized as uneconomical. A thin deposit of Ag stops further action of Fe and not all of the Ag in solution can be recovered by this means. Precipitation of Ag by Cu chips in agitated tanks at 30°-40° C. or by Cu sheets scraped at intervals is preferable. The Ag precipitated slime is washed and filtered off and then melted in crucibles under charcoal and fluxes. The temperature must be raised gradually to eliminate organic matter. Presence of chlorides results in Ag volatization losses. Scrap from mirror industry is prepared chemically and Ag precipitated with HCl. Ag is recovered from electroplating solutions (Ag-K-double cyanides) by means of Zn chips or sheets. When all of the Ag is precipitated, Zn is removed and the precipitate allowed to settle. The latter is melted under a soda-potash cover. In case the Ag content of the solution is too low, economical precipitation with concentrated NaCl solutions is recommended. Stirring and heating to 70°-80° C. are suggested. After settling as much as possible of the clear solution is siphoned off. A quantity of acid (H_2SO_4) water 3-4 times as large as the slime is added to the latter and precipitation of Ag with Zn scrap is completed. EF (3a)

Studies on Cast Red Brass. C. M. SAEGER, JR. *Foundry,* Vol. 62, June 1934, pages 20-23, 49-50, 52; July 1934, pages 18-20, 49. **Pouring Temperature in Casting Red Brass.** *Iron Age,* Vol. 134, Aug. 9, 1934, page 17. See "Studies on Cast Red Brass for the Establishment of a Basic Classification of Non-Ferrous Ingot Metals for Specification Purposes," *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 456. VSP (3a)

Recent Die Casting Developments. SAM TOUR & F. J. TOBIAS. *Foundry,* Vol. 62, Feb. 1934, pages 21-23, 62. See *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 384. VSP (3a)

Innovations in Foreign Non-Ferrous Metal Science (Neues aus der ausländischen Nichteisenmetallkunde). *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Oct. 14, 1934, page 644. The following recent advancements are briefly described: (1) method of Electrometallurgical Society Usine in Paris for processing Cu of low 0 content-deoxidation is attained by small additions of metals possessing high affinity to 0, (2) method of processing a new Al alloy as developed by Ruselite Corp., Milwaukee—alloy contains 85-96% Al, 3-10% Cu, .75-5% Cr, .1-5% Mo and for certain purposes .05-1% Ti, distinguished by high tensile strength and drawability, (3) Harris process of refining Pb, (4) Zn alloys containing up to 2% Cu and up to .1% Si, made by Belgian Zn plant in Chênée, (5) Pacz method of processing Al with exceptionally favorable mechanical and corrosion resisting properties, (6) method of Sulzer Co., Winterthur, Switzerland, for controlling cooling conditions of castings. GN (3a)

Blowing With Oxygenated Air Gives Improved Results in Converting Copper Matte. S. TONAKANOV. *Engineering & Mining Journal,* Vol. 135, Dec. 1934, pages 539-544. Advantages of using oxygenated air up to a maximum of 38% 0 in converting Cu matte are: (1) rate of converting is increased several times, (2) process temperature is raised, thereby improving the thermal balance without appreciably affecting the life of the lining, (3) tuyère punching is greatly decreased and the life of the tuyère prolonged, (4) normal slags of high fluidity are obtained, the ferrite content remaining practically unchanged, (5) Cu of normal quality is produced without more than the usual amount of impurities, particularly 0, and (6) SO_2 content of gases tends to increase. While results were obtained on a specially constructed converter, the method is applicable on a production scale. WHB (3a)

Melting of Aluminum (Die Praxis des Aluminium- Schmelzens). A. VON ZEERLEDER. *Aluminium,* Vol. 17, Dec. 1934, pages 196-201. General points to be observed in melting of Al and types of furnace for melting ingot and scrap are discussed. Special attention must be given to the oxide content of the melt, and methods to prevent excessive burning of metal are described. Ha (3a)

Electro-Deposition of Solder. C. C. DOWNIE. *Electrical Review,* Vol. 115, Oct. 12, 1934, page 479. Reviews progress made in the manufacture of solder by electrodeposition. MS (3a)

Refining Jeweler's Sweepings with Arsenic. C. C. DOWNIE. *Metal Progress,* Vol. 27, Jan. 1935, page 48. Gives data on use of arsenic for separation of Pt and related rare metals from precious metal scrap and smelter sweepings by addition of arsenic. WLC (3a)

Method and Equipment of Molding an Aluminum Casing by Means of Sand Core and Exterior Mold (Verfahren und Einrichtung zum Formen eines Aluminiumgehäuses mittels Sandkern und äusserer Kokillenform). FERD. BROBECK. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, pages 473-475. Author describes a special core molding device and the molding of the lower mold part of an Al casing for multiple cylinder internal combustion engines. Method described guarantees uniform wall thickness and weight of the castings. GN (3a)

3b. Ferrous

C. H. HERTY, SECTION EDITOR

Prevent Losses With Proper Gates and Risers. PAT DWYER. *Foundry,* Vol. 62, Jan. 1934, pages 30, 32-33 Feb. 1934, pages 30, 32, 35; Mar. 1934, pages 34, 37, 38; Apr. 1934, pages 41-42, 44; May 1934, pages 43-44, 46; June 1934, pages 36, 38, 41; July 1934, pages 33-34, 36. Instalment No. 48. Discusses gating problems in connection with large molds where a considerable volume of molten steel flows through the gates and where many precautionary and other features differ radically from those in vogue on smaller molds, especially those made in green sand. Information is chiefly an orderly arrangement of data on the subject published in 1914 by J. H. Hall. Instalment No. 49. Pouring multiple molds presents some advantages, but saving in metal in sprue scrap does not amount to much. Feeding head is necessary on all steel castings. Effectiveness of head may be increased if attention is paid to position of casting in mold, size and position of gate; temperature of metal and speed of pouring must be regulated to minimize sudden and unnatural shrinkage and thus relieve head from carrying most of the load. Instalment No. 50. Discusses location of heads and risers with respect to casting and explains the use of high risers and suitable volume of metal in body of riser. This is especially important in casting of valves and high pressure castings. Instalment No. 51. Deals with method of molding and pouring flanges and other castings of similar character designed for high pressure service. Castings are poured in a vertical instead of the usual horizontal position and are assembled for pouring in groups of 8 to 12 depending on size. Instalment No. 52. Discusses speed control in pouring. High temperature of metal is not detrimental for light, thin sections. Steel solidifies so rapidly that it does not burn the sand and does not set up difficult cleaning problem found in large casting poured with very hot metal. Large castings should be poured with comparatively cold metal and as slowly as temperature will permit. Due to high temperature attained in acid lined converters and electric furnaces, metal is readily handled in teapot type ladles and poured over the lip. Small castings are poured from hand shank ladles. Instalment No. 53. Large steel castings do not present any more diffculties than many small castings. Number of risers may be disposed over large castings in a manner so as to feed it properly. In small castings, particularly those of unequal sections, the metal freezes so rapidly that risers cannot function properly. Absolute soundness is required in castings, especially those which are machined. Considerable experimental work is needed to establish a method that will guarantee homogeneous and solid metal. Instalment No. 54. Discusses the use of cone risers. Saving in total amount of metal melted for a given tonnage of castings is made by use of cone shaped or tapered riser instead of the straight side riser. The base of this riser keeps metal liquid close to the casting. Pressure on metal in casting is determined by height of riser irrespective of diam. at top or bottom. Production in standardized sizes of core shells which enclose risers eliminate guess work. VSP (3b)

Effect of Non-Metallic Nuclei upon the Graphitization in Cast Iron. *Foundry Trade Journal,* London, Vol. 50, May 24, 1934, page 335. See *Metals & Alloys,* Sept. 1934, page MA 433. AIK (3b)

Properties and Uses of Cast Irons Made in Electric Furnaces (Proprietés et emplois des fontes électriques). *Journal du Four Electrique,* Vol. 43, Oct. 1934, pages 361-363. Generalities. JDG (3b)

Processing of a Shut-off Valve (Die Herstellung eines Sperrgehäuses). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Oct. 14, 1934, pages 436-438. Discusses pattern making and core box construction of a shut-off valve. GN (3b)

Hints Contributing to Reduction in Price and Improvement of Charge (Beachtenswerte Winke, die zur Verbilligung und Verbesserung der Gattierung beitragen). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Sept. 30, 1934, pages 405-406; Oct. 14, 1934, pages 428-429; Oct. 28, 1934, pages 449-451. Discusses the costs of numerous types of charge compositions for machinery castings of 18-25 mm. wall thickness, steam engine cylinders of 10-15 mm., 16-30 mm., and 31-50 mm. wall thickness. The considerations show that the costs of the liquid metal are strongly affected by choice of suitable types of Fe and correct ratio of finished casting to scrap metal. By selecting suitable Fe brands both cheaper and better charges can be attained. Cheapest Fe brands may be expensive due to a possible higher share of scrap. S content can be decreased considerably both by proper melting procedure and desulphurization in ladle. By addition of Ni-Cr and Mo in ladle there can be attained a charge particularly suitable for steam engine cylinders. Coarse graphite must be avoided. Pearlitic-sorbitic structure gives best results for steam engine cylinders. For wear resisting castings C content should not exceed 3.2%. With 3.2% C and .85-1% combined C pipe formation is least. Higher P contents are detrimental to wear resistance. Graphite disintegration, subsequently causing growing as apparent at higher temperatures must be counteracted by suitable charge compositions. GN (3b)

Gating of Malleable Castings (Das Anschneiden des Tempergusses). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Sept. 30, 1934, pages 401-405. Discusses the rules followed in gating malleable castings for obtaining castings free of pipes. Numerous examples of castings are described that in general show tendency to porosity in certain parts. The discussion in particular refers to gating of tube connecting pieces, considering proper arrangement and size of suction ports in relation to size of casting. Proper selection of charge composition and application of Ti bearing admixtures in melting low C malleable is pointed out. GN (3b)

Chemistry of the Basic Bessemer Process (Zur Chemie des Thomasverfahrens). ERICH LACHMEIER. *Die Metallbörse,* Vol. 24, Mar. 14, 1934, pages 325-326; Mar. 21, 1934, page 359; Mar. 28, 1934, page 391. The chemistry of the basic Bessemer process, which still plays an important role in Europe is considered at length and the roles of Fe-oxide, Mn-oxide, alumina, P_2O_5, S are considered with emphasis on the writer's own investigations and experiments at the Kaiser Wilhelm Institut für Eisenforschung. EF (3b)

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Steel Castings with Special Reference to the Tropenas Process. J. E. Mercer & D. K. Barclay. *Foundry Trade Journal,* London, Vol. 50, May 31, 1934, pages 343-346. A paper read before Middlesborough branch of the Institute of British Foundrymen. The Tropenas converter, patented in 1891 originally had a secondary set of tuyeres. These were brought into use during the combustion of CO to CO_2. The liquid iron is transferred to the converter, which is then set back until the metal just tips the bottom of the tuyeres. Care has to be taken in the selection of deoxidizers and the method of their use. Deoxidizers are various and include ferro-alloys of Si, Mn and Ti. Also Al and Ca or combination of 2 or more of the foregoing. They may be added to the bath in solid or liquid form. Authors state that converter steel does "hold up" better in the ladle than electric steel. Various reasons have been advanced to explain this superior fluidity. Converter steel responds to heat-treatment quite as readily as steel made by other processes. There appears to be little justification for the assertion that oxide inclusions retard refinement. AIK (3b)

Some Experiments in Making Medium Manganese Steels for Bridge Construction. P. A. Kudryavtzev & L. M. Sinaiski. *Domez,* No. 8, 1934, pages 38-43. In Russian. Heat of medium Mn steel containing 0.30 C, 1.36 Mn, 0.217 Si, 0.054 S and 0.039 P made in an 50 ton open hearth furnace is described in detail, both from the melting standpoint and the properties produced which were similar to the results of U. S. practice. (3b)

Sponge Iron Process and Its Significance in Alloy Steel Production (Das sogenannte Eisenschwamm-Verfahren und seine Bedeutung für die Edelstahl-Erzeugung). W. Berndt. *Die Metallbörse,* Vol. 24, Sept. 29, 1934, page 1242. The sponge Fe production of the Krupp-Vereinigte Stahlwerke according to the Edwin process amounted to 40 ton/day during 1930-32 after extensive preliminary tests since 1928. In spite of the commercial perfection, the sponge Fe production was abandoned in Germany in 1932. A new plant is planned at Kristiansand, Norway, where low grade Fe ores and cheap electric energy are available. Russia has just built a new plant at Iwanowo after several years' experimental research. A Russian analysis shows 1.07% C, 0.6% Si, 0.1% Mn and 0.027% S. EF (3b)

The New Mechanized Foundry of the Sinclair Iron Company, Limited. Vincent C. Faulkner. *Foundry Trade Journal,* Vol. 49, Nov. 30, 1933, pages 305-306. An article accompanied by 2 diagrams describing the continuous-casting plant recently installed at the Sinclair Iron Co., Ltd., Wellington, Shropshire, Eng. OWE (3b)

Melting Gray Iron in Air Furnaces. Duncan P. Forbes. *Foundry,* Vol. 62, Apr. 1934, pages 18-20, 48, 50. See "Air-Furnace Cast Iron," *Metals & Alloys,* Vol. 5, May 1934, page MA 226. VSP (3b)

Spins Molds After Pouring. Edwin Bremer. *Foundry,* Vol. 62, Apr. 1934, pages 26-27, 54. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 435. VSP (3b)

Controls Cupola Melting Operations. Frank G. Steinebach. *Foundry,* Vol. 62, Aug. 1934, pages 12-14, 44, 47. Complete control of foundry operations especially melting and molding, is an absolute necessity in production of satisfactory castings. Describes standards which permit complete control of operations and insure uniform results developed by the St. Mary's Foundry Co. The company produces a wide range of high test gray Fe castings for machine tools. VSP (3b)

The Casting Problem of Stainless Steel. Ernest G. Surgert. *Paper Trade Journal,* Vol. 99, Nov. 8, 1934, pages 43-45. Foundry problems related to the casting of stainless steel are stated. Metal shrinkage is one of the most important. In some cases it may be advantageous to cast the object in parts and weld them together. Cooperation of the foundryman and the user is recommended. CBJ (3b)

High Test Cast Iron by Proper Treatment of the Melt (Hochwertiger Grauguss durch richtige Schmelzenbehandlung). H. Reininger. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Oct. 14, 1934, pages 424-426. Discusses practical experiences in improving physical properties of cupola Fe by treatment with a special material marketed as K.31-B. Analysis: 2.06% Si, .124% S, .84% Mn, .32% P, 3.32% C. Of this material ½% of the melt to be treated is sufficient to attain considerable improvement due to deoxidation, degasification and refining. Castings possess a finely grained structure and are absolutely dense. K.31-B further possesses a highly desulphurizing action. For attaining optimum desulphurization the thinly liquid slag formed upon application of K.31-B must first be skimmed off. The favorable action of K.31-B makes possible use of higher share of scrap in cupola charge, thus decreasing material cost. These advantages also hold true in making melts of malleable cast Fe. GN (3b)

Spoiled Castings by Molding Sand [Causes and Prevention] (Ausschuss durch Formsand [Ursachen und Beseitigung]). M. Schied. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Oct. 14, 1934, pages 426-428; Oct. 28, 1934, pages 445-447; Nov. 11, 1934, pages 468-469. Author discusses at length causes leading to and remedies of avoiding spoiling of castings by improper condition of molding sand. There are discussed (1) burning of sand, (2) formation of gas holes, (3) fins, (4) rising of metal in mold, (5) washing away of molding sand, (6) hot cracks, (7) rusting of gray cast Fe. (1) Burning of sand on casting is due to low heat stability of sand that has been used too often. Virgin sand must be added to avoid this trouble. Besides high temperature stability sand must possess good gas permeability and sufficient mechanical properties. Amount of powdered coal in sand should not be too high. (2) Gas holes in casting are frequently due to too dense molding sand. Molding sand of sufficiently high gas permeability is required. (3) Fins may be caused by too dense molding sand, detrimental content of carbonates, improper casting technique, too wet molding sand, improper drying of mold, poor removal of air upon casting. (4) Rising can be avoided by taking care of proper casting pressure in all sections of casting. (5) Washing out of molding sand is generally due to wrong arrangement of gates. (6) Hot cracks are caused by improper cooling conditions, the mold is then frequently too dense. (7) to avoid rust formation of gray cast Fe high gas permeability, low Fe content and low moisture content of molding sand are required as well as rapid removal of casting from mold and not too high S content of liquid metal. GN (3b)

Manufacture of Tool Steel. J. H. Hruska. *Heat Treating & Forging,* Vol. 20, Nov. 1934, pages 538-541. Describes practice in the manufacture of ingots of tool-steels and spring steel. Includes table on the composition, ingot size, and method of melting of some of the more commonly known grades of domestic and foreign tool-steels. Very little crucible steel is being produced at present. Well killed grades are used exclusively. Small ingots predominate, molds being usually of the split type. Inverted taper and one-piece brick hot tops improve homogeneity. Electric steels are often bottom cast, but grades made in crucibles or high-frequency electric furnaces are teemed directly. Pouring temperatures do not exceed 2750°-2800°F. MS (3b)

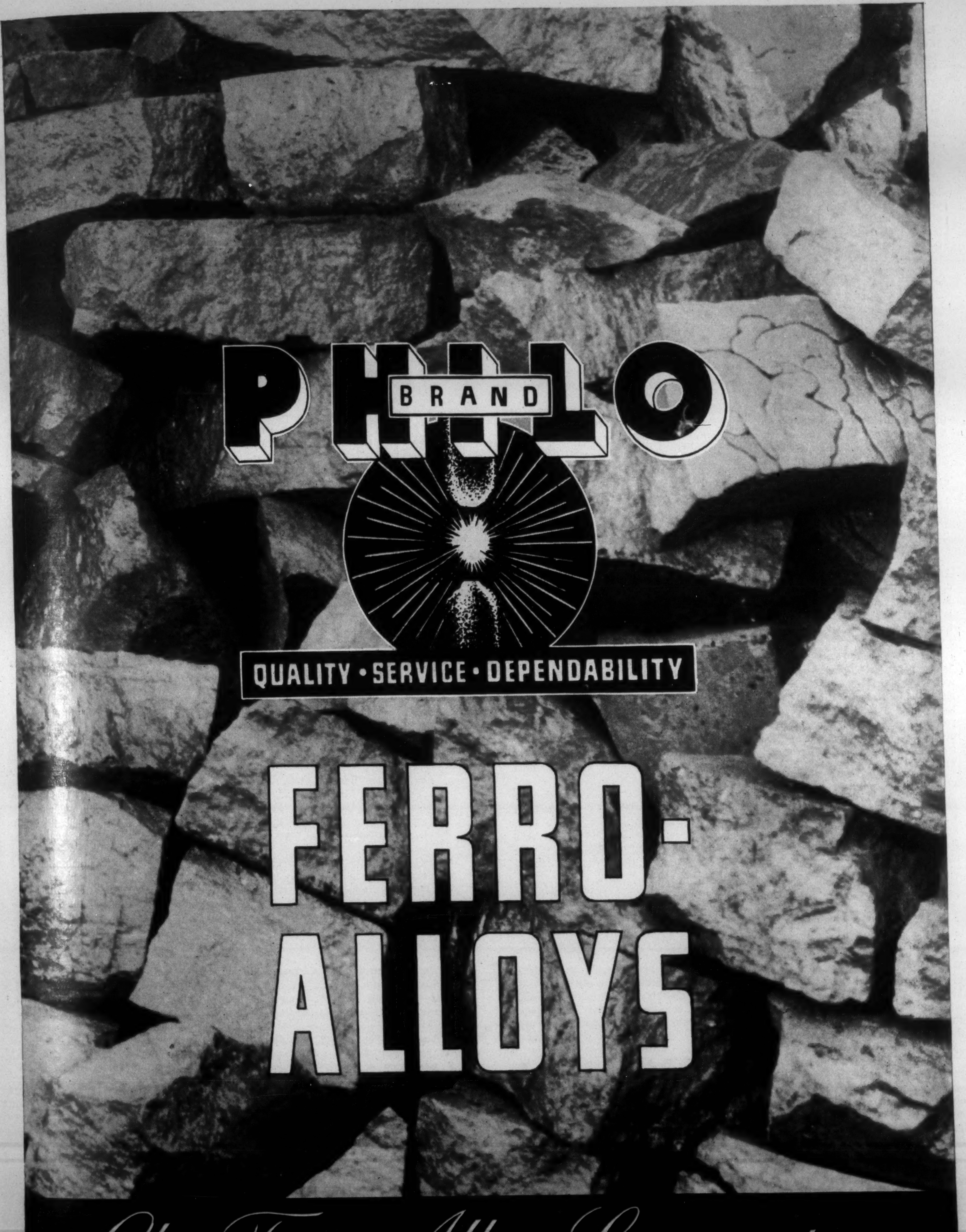
Studies on the Most Favorable Form of the Basic Bessemer Converter (Untersuchungen über die günstigste Form des Thomaskonverters). T. Heyden. *Stahl und Eisen,* Vol. 54, Nov. 29, 1934, pages 1225-1230; Dec. 6, 1934, pages 1256-1263. An extended study of oval and cylindrical shaped converters and of the effect of various features of design and operation on the efficiency. Oval shapes gave better performance. SE (3b)

Economic Operation of the Cupola (Wirtschaftlicher Betrieb des Kupolofens). H. Illies. *Feuerungstechnik,* Vol. 22, Feb. 15, 1934, pages 18-20. Five sources of resistance to be overcome by the cupola blast are pointed out, but 4 are small in comparison with the resistance offered by the height of charge. The resistance varies according to the amount of the blast. The maximum temperature in the melting zone is attained by a definite quantity of blast and the maximum height of the melting zone is limited by the maximum pressure produced by the blowers. The most favorable ratio of blast: pressure varies with different cupolas and charge compositions. This ratio should be determined experimentally. The use of instruments is indispensable. When the furnace lining wears out, the quantity of blast must be raised maintaining at the same time the highest possible pressure. The ratio blast: pressure cannot be regulated with the valves but only through the height of the melting zone. Longer deviations from the most suitable service conditions are remedied by reducing the quantity of coke. If the amount of blast rises with or without a drop of pressure, then the blast quantity is adjusted first with the aid of the valves followed by an increase of the coke portion. The most favorable blast quantity appears to be 150 $m.^3/min./m.^2$ tuyere area. The blast pressure tends to remain constant with diameters larger than 1 m. Contrary to prevailing conceptions the melting speed with the most favorable amount of blast cannot be speeded up by increasing the amount of coke or steel additions. WH (3b)

Defects Due to "Sand Seams" in Forged Locomotive Crankshafts (Fehlererscheinungen durch Sandstellen bei geschmiedeten Kurbelwellen). K. von Kerpely. *Stahl und Eisen,* Vol. 54, Nov. 8, pages 1153-1158; Nov. 15, 1934, pages 1180-1186. "Sand seams" in large locomotive crankshaft forgings are illustrated; these show up on the machined bearing surfaces as seams filled with rather large masses of refractory oxides. The frequency of the occurrence of sand seams in 40 basic open hearth heats was correlated with the heat records. The heats were of 30-tons; the ingots 9-tons; the steel plain C of about 70,000 $lbs./in.^2$ tensile strength. The heats with a low CaO/SiO_2 ratio of the slag and consequently with a lower FeO content of the slag gave fewer sand seams. These better heats were also tapped at a higher temperature, these 2 variables and the Si content of the charge being interdependent, since a higher Si content lowered the CaO/SiO_2 ratio and also raised the bath temperature. The correlations indicated that the following variables, these being either interdependent or independent, favored the elimination of sand seams. Pig iron with about 0.75% Si and 3% Mn to constitute about ½ of the charge. Total Mn in the charge at least 2%. C at melt down about 0.6% higher than the final analysis. Mn at melt down not less than 0.3%. Rate of C drop 0.21 to 0.25% per hr. A fluid slag with about 13% total FeO and about 18% MnO. A high value of the equilibrium constant $K_{Mn} = \dfrac{[Mn] : (FeO).}{(MnO)}$ The addition of FeMn at least 20 min. before tap. Tapping temp. 1530°C. Tapping time 4 min. Time held in ladle 10 min. Pouring temp. 1450° C. Rate of pouring 9.5 min. for a 9-ton ingot. SE (3b)

The Effect of the Type of Slag on the Structure of Pig and Cast Iron (Der Einfluss der Schlackenführung auf die Gefügeausbildung von Roh- und Gusseisen). E. Diepschlag & M. Michalke. *Die Giesserei,* Vol. 21, Nov. 23, 1934, pages 493-496. Pig Fe was remelted in an electric arc furnace under different slags. Castings obtained from such melts show, in spite of the same analysis, quite different structures depending on kind and handling of the slag. This effect of the slags must very likely be attributed to their different capacities to absorb oxidic elements from the melt which can act as germs for the crystallization of graphite. The so-called "hereditary properties" of identical kinds of pig Fe were found to have a certain relation to these oxidic inclusions. In general, the following conclusions could be drawn from the tests: 1) Lime-alumina slags with low content of SiO_2 show normal graphite in a pearlitic basic structure; with more than 10% SiO_2 in the slag the graphite eutectic occurs in varying amounts. 2) Lime-silicic acid slags with higher lime content show a particularly strong tendency to form the graphite eutectic; the same was observed in P-rich melts. 3) With lime-silicic acid slags with higher contents of SiO_2, disintegration ferrite with coarse graphite occurs preferably; the O content in some samples was as high as 0.0105%, but in normal and fine-eutectic graphite only 0.0019 and 0.025% resp. A relation of the kind of structure to the kind of pig Fe used could not be established. Hereditary properties can apparently be fully eliminated by suitable melting temperatures and melting times and by correct reaction with the slag. Ha (3b)

Casts Steel with External Chills. Ralph Burke. *Foundry,* Vol. 62, Sept. 1934, pages 23, 64. **How External Chills Regulate Cooling of Steel Castings.** *Steel,* Vol. 95, Oct. 15, 1934, page 55. External chills may be used to promote uniform rate of cooling in all sections. Checking of the casting surface next the chill face is caused by a heavy or rough chill or allowing the casting surface to adhere to the chill face. To prevent adherence of steel, chills must be smooth and protected by a coating such as shellac and dry sand. Cracking at periphery of chill may be reduced by chamfering edges of chill. Shrinks at sharp corners, caused by gases, can be eliminated by use of chills cast to fit the pattern accurately. Proper use of external chills increases yield of good castings by reducing size of risers. For regular C steel castings, safest practice is to confine use of chills to sections otherwise difficult to feed by risers. Chills are valuable in promoting soundness of intersections. MS + VSP (3b)



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Contribution to the Study of Graphite Formation and Structure in Cast Iron and its Influence upon the Properties of the Cast Metal. Heinrich Nipper. *Foudry Trade Journal, London,* Vol. 51, July 5, 1934, pages 7-14. Paper read before the Annual conference of the Institute of British Foundrymen held at Manchester on June 5-8, 1934. The effect of structure on physical properties of cast iron is discussed at length. The paper is illustrated with many micrographs. The micrographs of various types of graphite formations, particularly the examination of graphite flakes carried out in polarized light are of a great interest. In discussing the undercooling effect the author points out that the first effect of high superheating is to decrease viscosity, for the impurities in the melt coagulate and are separated out. Even in the case of hypereutectic melts, all particles are entirely dissolved at sufficient superheating. The surface area of graphite has to be in the most favorable proportion to the quantity present in the mass. Short, thick lamellae, not connected too closely to one another, and not too numerous, are the most favorable form. As it was shown by Heimes and Piwowarsky the wear largely increases with graphite of increasing fineness. The influence of structure on growth, corrosion, magnetic properties, thermal and electrical conductivities of cast iron are also discussed. AIK (3b)

The Equilibrium $FeS + Mn \rightleftarrows MnS + Fe$ at High Temperatures (Das Gleichgewicht $FeS + Mn \rightleftarrows MnS + Fe$ bei hohen Temperaturen). O. Meyer & F. Schulte. *Archiv für das Eisenhüttenwesen,* Vol. 8, Nov. 1934, pages 187-195. The equilibria between Fe melts containing Mn and pure sulphide slags (O_2 being excluded) were determined in laboratory melts. The equilibria may be expressed by the equations $K_1 = \frac{(Fe) \cdot [Mn]}{(Mn) \cdot [Fe]}$ and $K_2 = \frac{[S] \cdot [Mn]}{(S) \cdot [Fe]}$ over a wide range of concentrations. At 1600°C $K_1 = 0.00425 \pm 0.000125$ and $K_2 = 0.000725 \pm 0.000175$. C and Si additions to the bath changed only K_2. The heat effect of the reaction $FeS + Mn = Mns + Fe + Q$ was determined from the changes of K_1 with temperature to be 18 to 19 K cal/mol. From the Mn and S contents of the bath the product of $[Mn] . [S]$ at 1600° C. was found to be 2.6. In melts containing C this is lowered to 1.2 and in the temperature range 1350 to 1250°C the product is further lowered to 0.75. At such lower temperatures, therefore, desulphurization through the separation of pure sulphide can hardly be expected. SE (3b)

Gives Alternative Molding Methods. R. Löwer. *Foundry,* Vol. 62, July 1934, pages 24-25, 54. Local conditions, including available foundry rigging and personal preference constitute deciding factors in selecting a method of molding. A rigid loom mold resists pressure and weight of Fe more satisfactorily than sand mold, and produces casting free from swells and strains, and also provides secure foundation for heavy cores. Details of molding and core making depend on whether the core is in one or in several parts. Describes and illustrates methods adopted for molding a 75 in. blowing engine piston casting with an average metal thickness of 1½ in. VSP (3b)

Fluidity of Slags and Processes for Refining Steels: Dephosphorization (La fluidita della scoria e i processi d'affinazione dell'acciaio: Defosforazione). L. Losana. *La Metallurgia Italiana,* Vol. 26, Nov. 1934, pages 851-860. Three samples of P-bearing irons have been dephosphorized using basic slags of varying fluidity and the effect of this variation on the rate of dephosphorization measured. The compositions of the irons used were as follows:

	I	II	III
Total carbon	0.10 %	3.21 %	3.46%
Graphite	—	2.08	2.48
Mn	0.46	0.21	0.48
Si	0.11	0.58	0.96
P	0.012	0.032	2.40
S	0.008	0.097	0.10

The viscosity of the slags was measured as described in Part I, CaF_2 being added to one sample to give a higher fluidity. The dephosphorization was carried out at 1610°C., samples being taken for analysis at intervals of 10 minutes. The ratio of P in the steel and slag was determined. The time required for reaching an equilibrium in the dephosphorization was found to vary approximately as the fourth power of the *viscosity* of the slag. AWC (3b)

Nonuniform Hardness in Spite of Uniform Wall Thicknesses (Ungleichmässige Härte bei gleichmässigen Wandstärken). Gustav Krebs. *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 25, 1934, pages 485-486. Discusses causes of and remedies for this occurrence in castings of thin walls. Hard spots may be caused by presence of Fe- O compounds in melt, originating either from use of rusted scrap in charge or application of insufficiently dried ladles (metal then starts boiling and easily picks up O) or too high S content of melt. Most important remedy is proper arrangement of gates to attain rapid filling of mold to thus avoid oxidation to the greatest possible extent. Besides suitable arrangement of gates, casting procedure (high casting temperature and high casting speed) is very important. Proper making of pattern plate is finally touched upon. GN (3b)

Iron Refined by Griffin Duplex Process. Rogers A. Fiske. *Iron Age,* Vol. 134, Sept. 27, 1934, pages 13-17. Describes use of duplexing process at Chicago plant of Griffin Wheel Co. Process consists in use of pre-heated blast in cupola in combination with an air furnace fired with pulverized coal mixed with preheated air. Total fuel consumption including cupola and air furnace does not exceed 231 lb. per ton of Fe melted. Process is particularly adapted for production of high-test cast Fe. Gives tables showing relative economy from pre-heated blast in cupola and record of fuel consumption. Purpose of air furnace is to control the temperature of molten Fe, to insure liquefaction of C in Fe and control % of total C in Fe at predetermined amount. VSP (3b)

The Forehearth as Used in Iron Foundry Practice. George S. Evans. *Transactions American Foundrymen's Association,* Vol. 5, Dec. 1934, pages 1-20. A forehearth may be considered as the hearth of the cupola furnace, offset for receiving the metal from the cupola as melted and to better serve as a mixing and storage reservoir. Advantages of different types of forehearths are described and illustrated. By proper design and plant procedure loss of temperature may be minimized. The combined effect of higher melting temperatures and the refining may overbalance any loss in fluidity from temperature drop. Use of a forehearth tends to flatten out variations in temperature and composition of metal throughout the duration of the heat. Variations in design and lay-out of forehearths or teapot ladle equipment with relation to the cupola assembly are almost unlimited. More attention must be given to the matter of lining materials for forehearths and teapot ladles than in ordinary foundry practice. CEJ (3b)

Grain-Size Control of Open-Hearth Carbon Steels. S. Epstein, J. H. Nead & T. S. Washburn. *Transactions American Society for Metals,* Vol. 22, Dec. 1934, pages 942-978. 15 references. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention 1934, see *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 514. WLC (3b)

Making Quality Steels. Emil Gathmann. *Blast Furnace & Steel Plant,* Vol. 22, Aug. 1934, page 461; Sept. 1934, page 529; Oct. 1934, pages 585, 587; Nov. 1934, pages 645-647. To profit fully from the use of big-end-up sink-head ingots, an adjustable shrink-head casing should usually be employed so that no sound, homogeneous steel will be scrapped at the shears. Credit for first suggesting use of Cu in connection with ingot-molds should go to John Francis Bennett of Pittsburgh, who recommended it in U. S. Patent 282,241 issued July 21, 1883. Author thinks that present methods of using Cu stools or mold-bottom closures in which molten steel stream is allowed to impact directly on Cu face, will never be a metallurgical or commercial success. Cu is cut or considerable quantities of Cu oxide are washed or absorbed into the forming ingot by the high velocity stream of steel. Improvement on the Bennett idea will obviate these difficulties. Deals with segregation in ingots. One of the decided advantages of big-end-up contours over big-end-down is that the segregated area can be cropped and discarded without undue loss of sound ingot product. Presents charts showing sections and average yields of ingots made from killed, semi-killed and rimming steels cast in big-end-up and big-end-down molds. MS (3b)

Manufacture of a Cast Steel Runner of a Water Turbine (Herstellung eines Stahlgussläufers für eine Wasserturbine). C. Heiken. *Die Giesserei,* Vol. 21, Dec. 7, 1934, pages 517-520. Making of the mold is described in detail; special attention was paid to risers and gates to insure uniform cooling and to avoid gas inclusions and segregations. The diam. is 2400 mm., height 2000 mm. Ha (3b)

The Future of Cast Iron. L. B. Hunt. *Foundry Trade Journal,* Vol. 50, Apr. 19, 1934, pages 251-252. Further advances in the use of cast iron will be dependent, first, upon improvements in structure and, second, upon the more enlightened design and application of castings based upon a better understanding of the properties of cast iron. Improvements in structure will depend upon (a) composition (b) melting conditions. The objective is the production of uniform pearlite as free as possible from discontinuities, having the graphite in much finer flakes, and with as low a phosphorus content as possible. Cast iron will keep pace with developments in engineering practice. CEJ (3b)

Finishing the Heat of Steel. Pt. XXIII-XXVI. J. H. Hruska. *Blast Furace & Steel Plant,* Vol. 22, Aug. 1934, pages 454-455; Sept. 1934, pages 523, 541; Oct. 1934, pages 579-580; Nov. 1934, pages 638-639. These parts deal with elimination of piping; cooling of ingots after teeming; and principles, kinds, and determination of, and influence of ingot size on segregation. MS (3b)

Defects in Chromium Automotive Steel and Means for Their Elimination. P. Umrikhin. *Stahl,* Vol. 4, June, 1934, pages 1-10; July, 1934, pages 19-25. In Russian. Hair lines and cracks, which frequently appeared after rolling and forging in the Krasnuii Putilovetz plant (Leningrad) were due to insufficient deoxidation, addition of Fe-Cr to the bath before deoxidation, high MgO content in slag, addition of insufficient $CaCO_3$ during the oxidation period, and to lack of temperature control. HWR (3b)

The Use of Sodium Carbonate in Iron and Steel Works. N. L. Evans. *Foundry Trade Journal,* Vol. 50, Apr. 5, 1934, pages 223-226, 232. Paper read before the Sheffield Branch of the Institute of British Foundrymen. See *Metals & Alloys,* Vol. 5, Aug. 1934, page MA 385. CEJ (3b)

Road-Sett Foundry of the Stanton Ironworks Company, Ltd. Percy Fox-Allin. *Foundry Trade Journal,* Vol. 50, Apr. 19, 1934, pages 257-259. A description of foundry technique used in production of approximately half a million iron castings (each about a foot square with 2 in. as a maximum thickness) to be used for flooring the Mersey Tunnel. Castings are made against a special form of S-coated metal chill in order to insure a hard white outer surface and dense metal throughout. Mechanisation has been carried out but not beyond its economic limits. CEJ (3b)

Nonuniformity of Cast Iron Test Ingots. I. A. Andrejev & G. I. Stuckanowskaya. *Domez,* No. 9, 1934, pages 51-53. In Russian. Analytical investigation of the distribution of elements in cast iron test ingots showed practical lack of segregations justifying the usual practice of taking analytical samples by drilling in the middle of the ingot. (3b)

Dephosphorization of Bessemer Steels with Liquid Slags. F. Agaletzkii & S. Zaikov. *Stal,* Vol. 4, Aug. 1934, pages 21-29. In Russian. 15 ton heats of Bessemer steel immediately after blowing were poured into a ladle containing molten slag of the following composition: 7-10% SiO_2, 39-51% CaO, 17.5-22% FeO, and 0.14-0.34% P_2O_5. By the thorough mixing of the slag with the steel the P content in the steel was reduced from 0.070-0.080% down to 0.020-0.040%. C was reduced from appox. 0.15% to 0.02%, Si from 0.31-0.85% to traces, and Mn from 0.16-0.32% to 0.05-0.19%. After this treatment the steel was carburized and deoxidized. The finished steel had considerably fewer slag inclusions than ordinary Bessemer steel. HWR (3b)

Casting the Ford V-Eight Crankshaft. Burnham Finney. *Iron Age,* Vol. 133, Mar. 15, 1934, pages 28-31. Describes method of producing cast alloy steel crankshaft of high-C, high-Cu Cr-Si steel. Metal for castings is prepared in 2 5-ton electric furnaces, the charge consisting of 40% scrap and balance of pig Fe, back stock and alloys. Considers also a new method of making cores, a duplexing system for preparing steel for casting, analysis of steel, heat treatment and machining. VSP (3b)

Operating Results of a Cupola Furnace with Basic Lining (Betriebsergebnisse eines Kupolofenbetriebes mit basischer Zustellung). C. Heiken. *Die Giesserei,* Vol. 21, Oct. 26, 1934, pages 453-455. The influence of a basic lining of the cupola furnace on the operation, and on the composition of the product, in particular on the S and C content, was investigated. Fe made in such furnace had a high C content, average 3.69% and 4.3% maximum, while normally it is 2.85% average. By using 40-60% steel scrap the C content can be adjusted to the required amount. Si was low and is brought up to the necessary amount by adding high-percentage ferrosilicon to the melt. S could be held in this process within 0.04-0.06%. Ha (3b)

Segregation in Test Ingots. I. A. Andrejev & G. I. Stuckanowskaya. *Domez,* No. 8, 1934, pages 52-54. Splitting test ingots and determining the presence of dendrites by means of Baumann method showed that dendrite formation is caused by gas bubbles only. Dendrites cause segregations which were checked analytically. For better uniformity of the sample killing with Al is recommended. (3b)

Desulphurizing with Fused Soda. George S. Evans. *Foundry,* Vol. 62, May 1934, pages 26-27, 62, 64. From a paper read before the Quad-City Foundrymen's Association, Moline, Ill. At present desulphurizing is practiced regularly in either a teapot ladle or a forehearth in production of lawn mower, typewriter, sewing machine, etc., thin castings. For both light and heavy castings fused soda ash, known as Purite, is used. Usually with good melting practice and proper equipment S in cupola metal may be reduced 25 to 35% in light and 50 to 60% in heavy castings. It has also been determined that the treatment improves the structure, machinability and quality of finished castings. In malleable foundries soda ash is used for duplexing cupola metal and as a direct addition to air furnace charge. Used also in melting brass and Cu and in the steel industry. VSP (3b)

Molding 30-in. Cast Sheaves from a 22-in. Pattern. J. H. Eastham. *Iron Age,* Vol. 134, July 5, 1934, pages 15-17. Foundrymen are occasionally required to produce castings which are of larger or smaller size than any available pattern of design required. Describes method that was employed in molding the sheaves by using plaster of Paris to make extensions on pattern and core box. Experiment suggests possibilities beyond emergency work. VSP (3b)

Ford Foundry Casts V-8 Engine Crankshafts. Pat Dwyer. *Foundry,* Vol. 62, Apr. 1934, pages 14-17, 47. Discusses equipment and method used by the Ford Motor Co. in casting crankshafts. Metal charge is made up of approximately 50% steel scrap and 50% return crankshaft scrap. Metal produced is of following analysis: C 1.25-1.40%; Mn 0.50-0.60%; Si 1.90-2.10%; Cr 0.35-0.40%; Cu 2.50-2.75%; P 0.10% maximum; and S 0.06% maximum. VSP (3b)

Simplified Molding of the Stand of a Double Spindle Milling Machine (Vereinfachte Formung eines Ständers für eine Doppelspindelfräsmaschine). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Sept. 30, 1934, pages 413-415. Discusses at length molding procedure applied that brought about considerable advantages and savings. GN (3b)

Properties of Cast Iron Treated in an Electric Furnace (Note sur les Propriétés des Fontes Traiteés au Four Électrique a Saulnes). A. Le Thomas. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Aug. 1934, pages 356-363. Paper presented at Nancy Foundry Congress, July 1934. Blast furnace iron was treated in an electric furnace and pigged. After treatment, Si content is grading basis, Mn is 0.80% to 1.00%, P 0.07 to 0.30%, total C 2.40 to 2.80%. This metal had modulus of rupture from 85000 to 100000 lbs./in.^{2} in the transverse test and a modulus of elasticity of 23,000,000 lbs./in.^{2} For casting, the pig is remelted either alone or mixed, in a cupola. WHS (3b)

Steel Castings. W. H. Hatfield. *Iron & Coal Trades Review,* Vol. 129, Oct. 26, 1934, pages 638-640; Nov. 2, 1934, pages 682-684. Exchange paper presented in behalf of the Institute of British Foundrymen to the American Foundrymen's Association. Special conditions of British and American foundries are pointed out which make for greater diversity in demands on English steel foundries. The position of research molding practice, casting and examples of castings are described. The essential differences of steel forgings from steel castings are explained; the former come from a sound steel ingot and are, therefore, inherently sounder than a steel casting to which, consequently, a greater factor of safety is applied. Close cooperation between designer, engineer and steel founder is emphasized to produce sound castings economically. Ha (3b)

Alloys in the Iron Foundry. J. Roxburgh. *Foundry Trade Journal,* Vol. 50, May 24, 1934, pages 329-331. Paper presented to the Sheffield Branch of the Institute of British Foundrymen.. Sometimes there is a tendency to believe that alloys are cure alls, but the author recommends getting the most out of ordinary irons and only resort to the use of alloys where special circumstances demand it. Alloy can be supplied as a ferro-alloy, as pure ingot, as shot or in powder form or briquettes. The addition of powdered ferro-chrome to the ladle is not recommended by the author. He prefers the use of Cr briquettes, containing a little C, liquefaction of which takes place more readily and rapidly owing to their lower melting point. These briquettes yield their Cr to the molten Fe without absorption of C and with practically no loss. Regarding Ni, this can be added to the cupola in the form of Ni ingot or sheet and approximately 2.5% loss should be allowed for. Provided that there is sufficient metal to be run into a ladle, the "F" Ni shot can be added down the spout. This shot has a lower melting point, approximately 1260° C., and contains 92% Ni and about 6-8% Si. The author has found that it is essential to melt iron containing Mo, twice or even three times before uniformity of analysis and structure is obtained. Very special alloy irons such as Ni-Resist or Nimol or Nicrosilal are best melted in crucible furnaces. Melting losses in various types of furnaces are shown. AIK (3b)

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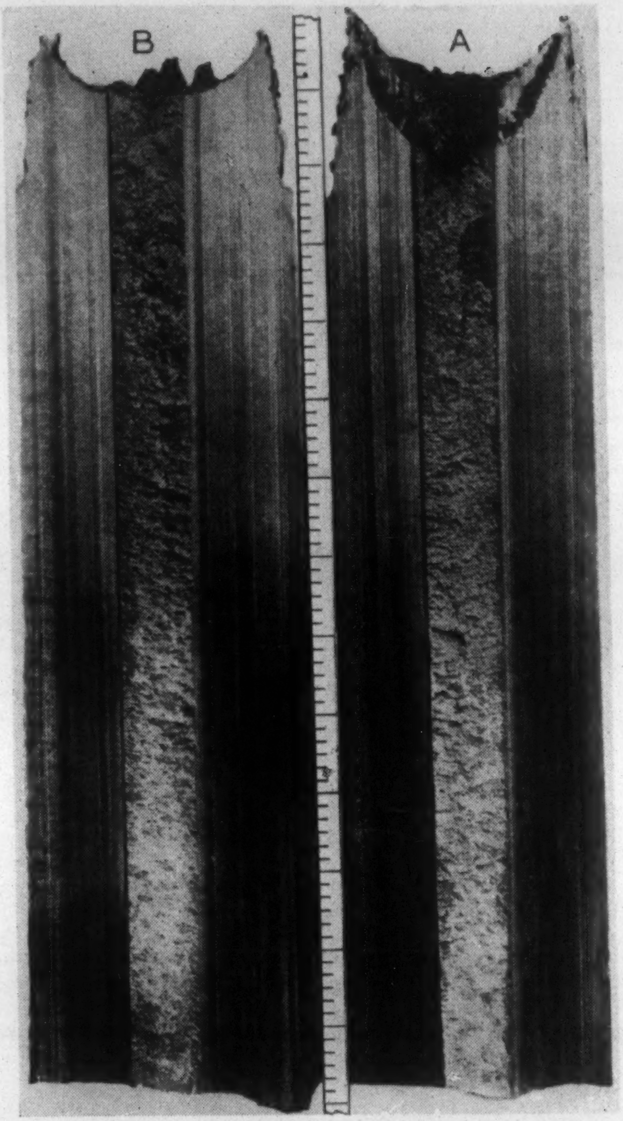

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4. WORKING

4a. Rolling

RICHARD RIMBACH, SECTION EDITOR

Direct Rolling of Molten Steel (Unmittelbares Auswalzen von flüssigem Stahl). H. Bleckmann. *Stahl und Eisen*, Vol. 54, Nov. 15, 1934, pages 1177-1180. The idea of direct rolling of molten steel between chilled rolls is quite old having been proposed by Bessemer in 1858, but the technical means for its realization have been lacking. An experimental set-up is illustrated in which a regulated flow of molten steel is fed between water-cooled copper rolls, the chilled steel being rolled out into plates while still in the mushy state. The difficulties are in regulating the rate of flow, chill, and rolling speed, so that the process can go on continuously. These difficulties have as yet by no means been overcome. Specimens of steel plates thus rolled, about 3/8" thick, showed an almost total absence of dendritic structure. SE (4a)

Wide Flanged Beams. W. Trinks. *Blast Furnace & Steel Plant*, Vol. 22, Sept. 1934, page 531. Only 2 mills in the United States roll such beams. Modern wide-flanged beam mills require large investment. Smaller companies can consider 2 methods. First is the Puppe mill, which, in 2 stands, rolls beams up to 15 in. in width, and has a capacity of 9,000-14,000 tons per month. A disadvantage is that in a few sizes of beams or columns, fins are produced on the edges of the flanges. Other method involves welding separate sections together. One process consists of welding flanges with center projections to a web which fits into the projections. Current flows between a C electrode and a Cu electrode, producing resistance welding between web and flange and fusing part of the projection. With welding, webs can be produced thinner than they can be made by rolling, and beams of variable depth can be produced. MS (4a)

Power Requirements for Cold-Strip Rolling. T. R. Rhea. *Iron Age*, Vol. 134 Aug. 23, 1934, pages 26-28, 69. Presents data in a form as to be conveniently usable in determining H.P. capacity necessary to drive a particular stand or to take an amount of draft at a particular speed. Data were taken from: (1) Tandem mills; (2) Reversing cold strip mills with power applied to main rolls and to both reels; and (3) Reversing cold-strip mills with power applied to reels only (Steckel type). Data shown in curves is for mild steel which was pickled after coming from hot-strip mill. No data available on alloy steels. Gives method of calculating. VSP (4a)

Rolling Steel for Quality. W. H. Melaney. *Blast Furnace & Steel Plant*, Vol. 22, Nov. 1934, page 647. Points out that an oversight on the part of the rolling-mill operator can make worthless the finest quality of steel in the ingot form. Examples are the formation of cracks or seams by carrying the slabbing action to the extreme with no attention to the amount of spread and by use of too much H_2O on the rolls during the rolling process. MS (4a)

Industrial Lubrication and Lubricants. O. L. Maag. *Blast Furnace & Steel Plant*, Vol. 22, Nov. 1934, pages 625-626, 644. **Selecting Proper Lubricants for Antifriction Bearings.** *Steel*, Vol. 95, Dec. 3, 1934, pages 31-32, 52. Paper read before the National Association of Lubricating Grease Manufacturers, Oct. 16-17, 1934. Includes discussion of lubricants for steel-mill equipment. Recommends extreme pressure lubricants for this service. MS (4a)

Continuous Mills Voracious in Cost, but How They Produce! John D. Knox. *Steel*, Vol. 95, Oct. 22, 1934, pages 18-19, 23. In narrative form. Continuous wide strip-sheet mills cost from $4,000,000 to more than $8,000,000. Such a mill with a total crew of 126 men can produce 2,500 tons a day. It would take 96 sheet mills of the conventional type with a combined crew of 4,500 men to produce an equivalent tonnage. New applications for steel will have to be developed to satisfy a large part of the potential tonnage of more than 6,000,000 tons which will be produced by the 11 mills built, building, or contemplated. MS (4a)

Individual Motor Drives Serve Runout Table and Coilers. C. V. Gregory. *Steel*, Vol. 95, Oct. 29, 1934, pages 25-27, 39. Table rollers on the 20" and 72" continuous strip mills at the Riverside plant of the Otis Steel Co., Cleveland, O., are driven individually by squirrel-cage motors which operate on adjustable frequency and voltage to provide a table speed of 600-1200 ft./min. Rollers are stopped by braking the motors with d.c. Each of the 2 coilers on the 72" mill is equipped with 8 fully-inclosed, fan-cooled, squirrel-cage motors. MS (4a)

Machine Elements in Rolling Mills and their Maintenance (Maschinenelemente im Walzwerksbau und ihre Pflege). E. Howahr. *Stahl und Eisen*, Vol. 54, Oct. 25, 1934, pages 1101-1108; Nov. 1, 1934, pages 1132-1139. Proper maintenance of machine parts aids new developments. Thus with the use of pressure lubrication have come better bearings. New types of screw-downs, water cooling, couplings, rollways, etc., are discussed and illustrated. SE (4a)

Canadian Brass Rolling Mill Represents Advanced Practice. James R. Coe. *Iron Age*, Vol. 134, Sept. 27, 1934, pages 22-27, 79. Describes plant of Anaconda American Brass Co., Ltd., New Toronto, Ontario. Mill is designed to roll heavy strips. Economies have been secured by ingenious English and German methods in combination with original American developments. VSP (4a)

Orientation of Metallic Crystals and Solubility (Orientamento del cristalliti metallici e solubilita). Vincenzo Cagliotti. *Atti del congresso nazionale di chimica pura ed applicata*, Vol. 4, 1933, pages 442-446. The corrosion resistance of Al sheets submitted to a one-sided and universal rolling was tested in HCl by determination of the H liberated. The solution velocity of Al sheets rolled only on one-side and in which the rolling structure could be clearly shown by X-rays was found to be much slower. It could not be decided whethe this was due to different potentials along different planes or to a certain distribution of impurities. EF (4a)

New Recording Apparatus for Remote Recording of Roll Pressure (Neue schreibende Geräte für Fernanzeige von Walzdrücken). *Elektrotechnische Zeitschrift*, Vol. 55, Nov. 15, 1934, pages 1120-1121. A number of electrically operated instruments for supervising and recording continuously the pressure of the rolls during operation is described. Ha (4a)

Eliminating Surface Defects. *Blast Furnace & Steel Plant*, Vol. 22, Aug. 1934, pages 449-450; *Heat Treating & Forging*, Vol. 20, Aug. 1934, pages 390-392. Outlines practice of Timken Steel & Tube Co. on rolled alloy steels, with special reference to seamless tubes. MS (4a)

Maintaining Uniform Sections in Rolling Alloy Steels. *Steel*, Vol. 95, Sept. 3, 1934; pages 36, 38. Outlines practice of Timken Steel & Tube Co. MS (4a)

Maintenance of Roll Surface. Eric R. Mort. *Blast Furnace & Steel Plant*, Vol. 22, June 1934, page 354; July 1934, page 414; Aug. 1934, page 474; Sept. 1934, page 538; Oct. 1934, page 598; Nov. 1934, page 658. Excerpt from paper read before the Iron & Steel Institute. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. MS (4a)

Manufacture of Full-finished Steel Sheets. Eric R. Mort. *Machinery*, London, Vol. 44, June 14, 1934, pages 314-316; June 28, 1934, pages 380-382; July 5, 1934, page 411; July 12, 1934, page 450; July 19, 1934, page 470; July 26, 1934, page 498; *Blast Furnace & Steel Plant*, Vol. 22, July 1934, pages 389-391, 398; Aug. 1934, pages 452-453, 472; Sept. 1934, pages 520-522; Oct. 1934, pages 581-582. See *Metals & Alloys*, Vol. 5, Oct. 1934, page MA 474. MS+WB (4a)

4b. Forging & Extruding

A. W. DEMMLER, SECTION EDITOR

Drop Forging Turnbuckles; New Device May Extend Their Use. *Steel*, Vol. 95, Sept. 17, 1934, pages 45-46. Describes practice of Cleveland City Forge Co., in forging turnbuckles from steel bars or billets. In making larger sizes, stock is cropped to length, rough forged, reheated, and forged to finished shape. Die blocks used for dies are of high-C, Cr-Ni steel heat treated to a scleroscope hardness of 50-55. Describes also the "Pittweld" turnbuckle device developed by the Pittsburgh Welding Corp. for taking up slack in inactive eye-bars of pin- and link-type bridges. MS (4b)

Revolutionize Plaster Model Work by Tin Spray. C. K. Stipp. *Metallizer*, Vol. 3, Oct. 31, 1934, page 4. A thin coating of tin applied by metal spray over the plaster die model used in the Keller Automatic Die Sinker is found to be very effective in protecting sharp edges and prolonging the life of the model. Small changes in the die model can be readily made by building a heavy sprayed coating where desired and filing or scraping down to size. BWG (4b)

New Process for Producing Hollow Ingots. *Machinery*, London, Vol. 44, Aug. 23, 1934, page 628. The Brearly Ingot Company, Ltd., has been organized to operate a hollow ingot patent which allows the ingot after stripping and reheating to be forged into boiler drums, containers, etc. WB (4b)

The Effect of McQuaid-Ehn Grain-Size of Steel in Forging. W. E. Sanders. *Transactions American Society for Metals*, Vol. 22, Dec. 1934, pages 1051-1068. Paper read and discussed before Grain-Size Symposium, A.S.M. Convention, 1934, previously abstracted from Preprint 17, 1934. See *Metals & Alloys*, Vol. 5, Nov. 1934, page MA515. WLC (4b)

The Flow of Metals During the Extrusion Process. C. E. Pearson. *Machinery*, London, Vol. 145, Dec. 13, 1934, page 401. Report of experimental work on inverted extrusion of beeswax, plasticine, specially prepared brass and tin billets. The use of recessed pad to trap oxide skin of the billet not successful, but if clearance is allowed between follower pad and container, the entire shell of the billet is left in the container. Curves of extruding pressure vs. length of billet show practically constant pressure for the inverted process. Pressure required for certain extrusion rates at various temperatures is given for Cd, Bi, Sn and Pb. Consumption of power by various dies shown. WB (4b)

Forging Certain Copper Alloys. E. Berthelman. *Metallurgia*, Vol. 11, Dec. 1934, pages 45-48. Gives directions for forging a bronze containing from 4.5 to 6% Sn, Al bronzes containing 9 to 11% Al and different amounts of Ni Fe and Mn, and special β brass-containing Mn and Al. Information is based on experience at Polish plant. JLG (4b)

New Methods of Extrusion Improve Lead Sheath. Herbert R. Simonds. *Iron Age*, Vol. 134, July 19, 1934, pages 18-21. Discusses investigation conducted by W. L. Sherman of John Robertson Co., Brooklyn to improve not only dies and equipment, but principally the quality of extruded Pb products. Main attention was paid to the poured-in process. Cylinder was preheated to 220° F. at the start. No lubricants were used during tests to eliminate "dirt" streaks especially at time of refilling. Die design is of importance in Pb coating of cables. VSP (4b)

Extruded Steel Forgings. Edwin F. Cone. *Heat Treating & Forging*, Vol. 20, Aug. 1934, pages 382-384. Similar to *Steel*, Vol. 94, May 7, 1934, pages 25-27. See *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 390. MS (4b)

4c. Cold Working, including Shearing, Punching, Drawing & Stamping

A Comparison of Cold Headed and Machined Screws. P. MABB. *Machinery,* London, Vol. 44, July 12, 1934, pages 431-433. Machined screws have a higher yield torque than untreated cold headed screws. There is a surprising increase in torque strength of screws that have been zinc plated. Cold heading where stock is responsive to heat treatment is suggested. Cold heading is more economical than machining and gives a superior product in tests of compound stress. WB (4c)

Working of Aluminum and Oils (Aluminiumverarbeitung und Oele). K. KREKELER. *Aluminium,* Vol. 17, Sept. 1934, pages 37-38. The selection of an oil for working of Al must consider whether the process is chipless or chip-forming. In the former case, special oils of various viscosities and high flash point must be used for rolling, pressing and drawing. For machining processes, emulsifying oils must be applied. Ha (4c)

Cold Drawing Steel. WM. M. WALLACE. *Heat Treating & Forging,* Vol. 20, Nov. 1934, pages 555-557. Recently developed lubricant incorporates a metallic compound with the oily or greasy constituent, making the use of the customary lime coat unnecessary. Pits in the finished product are thus avoided, but the benefits of the lime coat are retained. Most prevalent method of application is to dip steel into a hot solution of compound and H_2O. On difficult shapes and heavy reductions, a stream of solution is applied by a pump. Work is being conducted on a special compound for use in the box just as a grease for wire drawing. MS (4c)

Molybdenum Die Steel Has Long Life in Can Making. *Steel,* Vol. 95, Aug. 27, 1934, page 29. Non-deforming, deep-hardening steel for blanking-dies for tin-plate contains 12.5% Cr, 0.8-1% Mo, 1% V, and 1.6% C. This replaces a steel containing 12.5% Cr and 2.25% C. Total die life with new steel averages 35,000,000 can ends, while that with old steel was 10,000,000, both being handled the same. Regrindings are at the rate of 143 a year with the new steel as compared with 500 for the other. Die cost with Cr-Mo-V steel is 71% less. There is a saving of 1071 press-hours a year. MS (4c)

The Importance of Grain-Size of Sheet Steel for Deep Drawing. REID L. KENYON. *Transactions American Society for Metals,* Vol. 22, Dec. 1934, pages 1099-1119. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention, 1934. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 515. WLC (4c)

Wire Drawing at the Higher Speeds. J. B. NEALEY. *Iron Age,* Vol. 134, July 12, 1934, pages 16-18, 80. See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 8. VSP (4c)

4d. Machining

H. W. GRAHAM, SECTION EDITOR

Special Equipment Employed in Machining Large Caliber Guns. M. M. MCCALL. *Iron Age,* Vol. 134, Aug. 23, 1934, pages 10-15, 68. Describes the special machine tool equipment for the rough and finish turning and boring of the tubes, jackets and hoops, and for rifling the finished bore. The guns are forged from large ingots. Forgings for tubes are solid, but when size of hole is large enough the jackets and hoops are hollow forged. VSP (4d)

Grain-Size in Relation to Machinability and Other Properties of Bessemer Screw Steel. H. W. GRAHAM. *Transactions American Society for Metals,* Vol. 22, Dec. 1934, pages 926-941. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention, 1934 and previously abstracted from Preprint 10, 1934. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 516. WLC (4d)

Correlation of Metal-cutting Data. ROBERT COREY DEALE. *Mechanical Engineering,* Vol. 55, Oct. 1933, pages 625-627. This is not a correlation of metal-cutting data, nor does it include a bibliography; author describes, as Sec'y of ASME Subcommittee on Metal-cutting Data, its project for systematic correlation of all pertinent data—available and to be obtained in future. MFB (4d)

Modern Equipment Speeds Rail Sawing. *Railway Engineering & Maintenance,* Vol. 30, Jan. 1934, pages 21-24. A description of the Chesapeake & Ohio rail cropping plant at Barboursville, W. Va., and an account of the manner of its operation to obtain output of from 300-400 rails/8 hr.-day at a cost that justifies the hauling of the rail to this central location. WH (4d)

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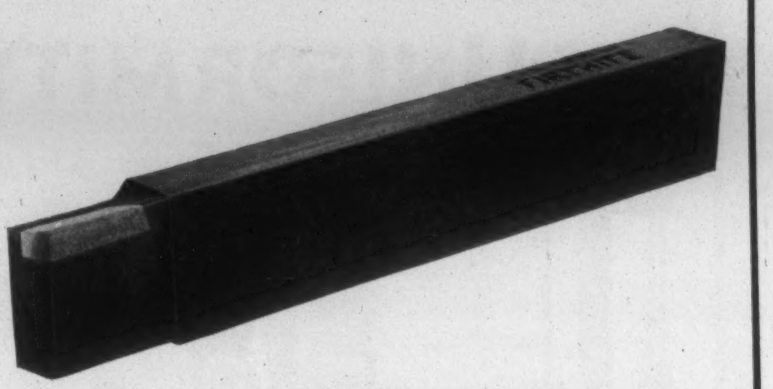

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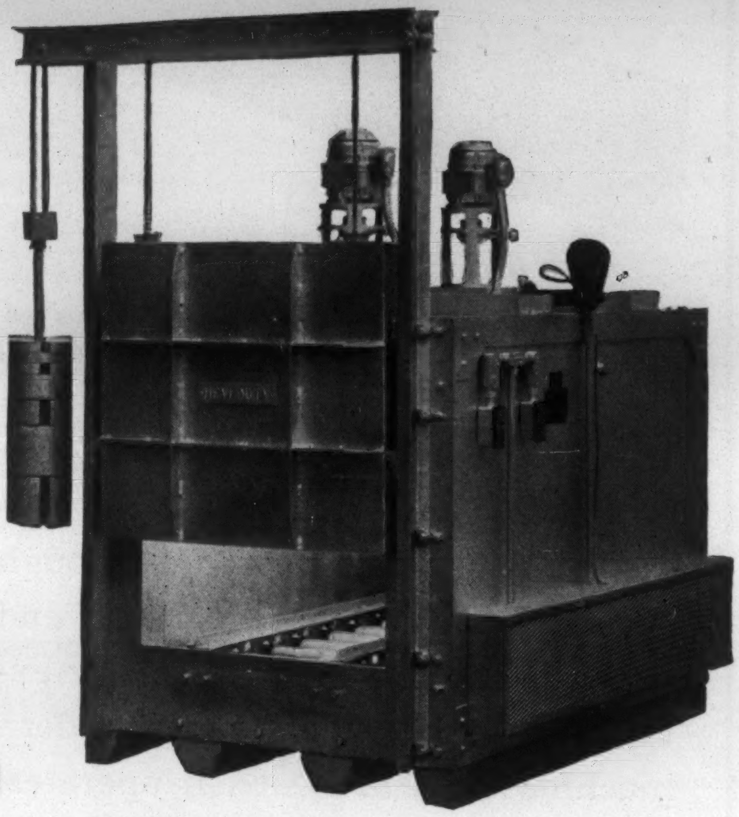

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5. HEAT TREATMENT

O. E. HARDER, SECTION EDITOR

Heat Treatment. A. McNab. *Journal Institution of Production Engineers,* Vol. 13, Sept. 1934, pages 676-484; S. Wood. Pages 485-492. Includes discussion. Elementary accounts of the changes which occur in steel during heat-treatment and of the usual methods of mechanical testing. JCC (5)

5a. Annealing

Self Annealing of Chill Cast Iron (L'Autorecuit des Fontes Trempées sur Coquilles Minces, Principes et Applications Pratiques). G. Henon. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, July 1934, pages 306-314. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 562. WHS (5a)

New Sheet Annealing Unit Reduces Heating and Cooling Time. *Iron Age,* Vol. 134, Sept. 27, 1934, page 35. Describes a box annealing unit consisting of a cover and bottom that together form a furnace for annealing sheet steel. Numerous advantages are claimed for it. It was developed by Lee Wilson Engineering Co., Cleveland. VSP (5a)

5b. Hardening, Quenching & Drawing

Practical Differentiation of Precipitation Hardening from Martensite Hardening (Über die praktische Unterscheidung von Ausscheidungs—und Martensithärtung). F. Sauerwald & H. Gross. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 221, Dec. 28, 1934, pages 159-160. In studies of Fe-C-Cr alloys where both types of hardness occur, it was desired to know whether the hardness of 600 Brinell is produced by the anneal at 870°C. or by the martensite at lower temperatures. High temperature measurements were made with Poldi hammer during the ½ to ¾ hours of cooling from the anneal. Hardness increase found to begin between 200°-300°C. therefore martensite was responsible. WB (5b)

The Micrometer—A Hardening Room Accessory. Matthew L. Clark. *Heat Treating & Forging,* Vol. 20, Nov. 1934, pages 536-537. Illustrates how the use of the micrometer aids in determining the exact conditions for hardening tool-steels such as those containing 0.90-0.95% C and 0.15-0.20% V so that tools are produced without distortion of any kind and exactly to size. MS (5b)

Heating Tool Steel. M. L. Clark. *Heat Treating & Forging,* Vol. 20, Oct. 1934, pages 495-496. Gives some practical suggestions for heating C and C-V tool-steel. Piece of tool-steel should never be placed into a hardening furnace with a temperature above 800°F. Recommends a heating time of 1¼ hrs. per in. thickness. Even if piece is only ½ in. thick, time should be 1 hr. MS (5b)

Effect of Temperature and Transformation Stresses in Quenched Hollow Steel Cylinders (Zusammenwirken von Wärme—und Umwandlungsspannungen in abgeschreckten Hohlzylindern aus Stahl). H. Bühler & E. Scheil. *Archiv für das Eisenhüttenwesen,* Vol. 8, Nov. 1934, pages 219-222. To round out previous work on the internal stresses in hollow cylinders of structural steel, experiments were made on hollow cylinders 50 mm. diam., 350 mm. long of various Ni steels. In steels in which the γ — α transformation occurred at relatively high temperatures, small holes through the center changed the stress distribution on quenching but little from that in solid cylinders; in this case the outside surface was in compression and the inside surface about the hole in tension. With lower transformation temperatures compressive stresses formed at both the inner and outer surfaces with tensional stresses in between. With still lower Ar″ temperatures tensional stresses occurred at the inner and outer surfaces with compressional stresses in between. In ordinary structural steels in which the transformation occurs during or after the change in thermal stresses, the residual stresses when small holes were bored were also similar to those in solid cylinders. With larger holes very large tensional stresses occur at the interior surface; these can be lowered by quenching the cylinder from inside the hole. Further increase in the size of the hole lowered the internal stresses in quenched hollow cylinders. SE (5b)

The Prevention of Distortion in Steel during Heat Treatment. W. Brazenall. *Journal Institution of Production Engineers,* Vol. 13, Sept. 1934, pages 459-475. Includes discussion. Forging and machining strains must first be removed by annealing, preferably at a temperature above that of final heat treatment. Warping in this operation must be corrected by hot straightening; followed, if necessary by re-annealing. In subsequent heat treatment, heating must be slow and uniform, and quenching as uniform as possible. The construction of a broach 36 in. long is considered. A hyper-eutectoid chromium-tungsten steel is recommended for this. JCC (5b)

Processing of Wheel Tires (Die Herstellung von Radreifen). *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Nov. 11, 1934, pages 725-726. Paper first describes wheel tire rolling mills as built by Demag Co., Duisburg and then considers difficulties encountered in subsequent heat treating processes Frequent failures of tires observed by a Roumanian steel mill in impact tests could be traced to hair cracks resulting from pipes. By changing ingot practice and installing an electric heat treating unit, composed of 5 small and one large electric heat treating furnace these failures were almost completely overcome. GN (5b)

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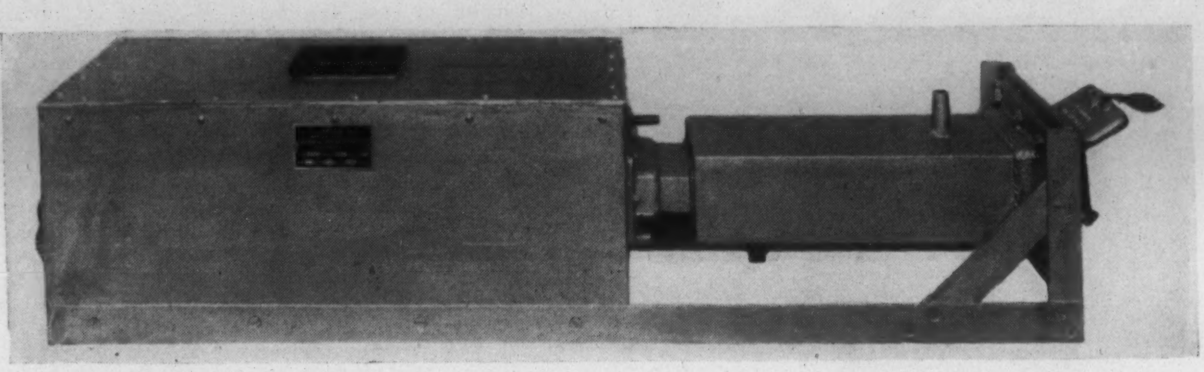

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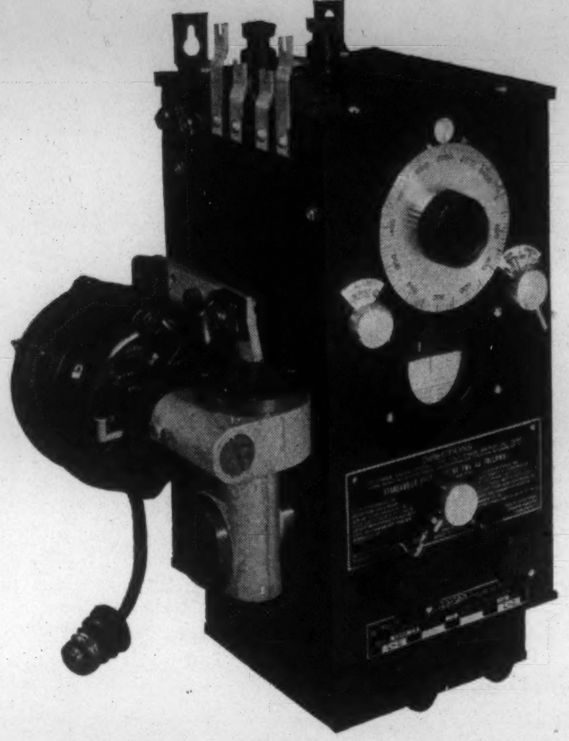

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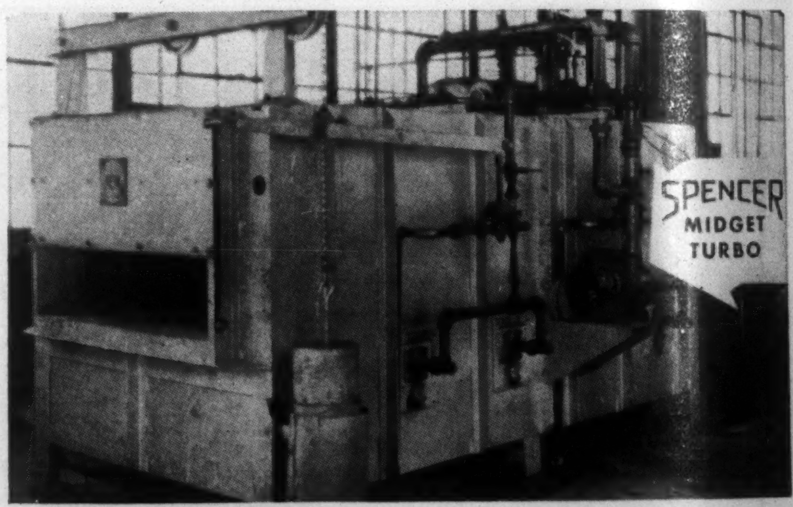
Embrittlement of Low-Carbon Steel. F. C. LEA & R. N. ARNOLD. *Iron & Coal Trades Review,* Vol. 129, Oct. 5, 1934, page 506. Internal change in low C steel is promoted if it is left unstressed at atmospheric temperature after water-quenching from 650° C.; the change occurs rapidly at first but after an aging period of 30 days equilibrium is attained resulting in increased hardness, tensile strength and fatigue limit while ductility and resistance to impact are reduced. A steel with 0.12% C showed an increase of 55% in hardness and 43% in tensile strength and a decrease of 75% in impact value. Magnitude of change depends on C content, the lower C, the more pronounced the effect. Water-quenching of low C steel in the region of 750° produces instantaneous brittleness, at higher temperatures in the critical range it has a less drastic effect. Maximum brittleness occurs in the range of 675-775° C. and is particularly pronounced in 0.12% steel. Quenching such steel from 800° and aging at atmospheric temperature for 50 days produces superior mechanical properties (40 tons/in.^{2} tensile strength and 40 ft. lbs. impact value). Age embrittlement after quenching from 700° C. may be entirely counteracted by aging at 100° for 4 hrs. which also produces increased hardness. Age embrittlement of low C steel at atmospheric temperature is ascribed to some internal movement within the crystal lattice which would, so far, not yet be identified by X-ray analysis. Embrittlement phenomena may also occur in normal case-hardening treatments; a hardening temperature of 800° C. is recommended followed by tempering for a few hours between 100° and 200° in order to obviate brittleness in the core.
Ha (5b)

5c. Aging

Internal Stresses Resulting from Precipitation Hardening (Eigenspannungen durch Ausscheidungshärtung). H. BÜHLER & W. TONN. *Stahl und Eisen,* Vol. 54, Oct. 25, 1934, pages 1108-1110. Cylinders of low alloy Cr-Cu steels and Fe-W alloys were treated to give precipitation hardening. This resulted in the formation of compressive stresses at the interior and tensional stresses at the exterior. In the Cr-Cu steels these stresses were no greater than after normalizing, but reversed.
SE (5c)

Aging Phenomena of Mild Steel Sheets. ANSON HAYES, R. O. GRIFFIS, REID L. KENYON & ROBERT S. BURNS. *Steel,* Vol. 92, May 29, 1933, pages 23-25; *Automotive Industries,* Vol. 69, July 29, 1933, pages 116-120; Aug. 5, 1933, pages 158-159. See "The Aging of Mild Steel Sheets," *Metals & Alloys,* Vol. 5, Mar. 1934, page MA 94.
DTR + MS (5c)

Prolonged Tempering at 100° Centigrade and Aging at Room Temperature of 0.8% Carbon Steel. G. A. ELLINGER & R. L. SANFORD. *Bureau of Standards Journal of Research,* Vol. 13, Aug. 1934, pages 259-266. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 518.
WAT (5c)



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6. FURNACES, REFRACTORIES AND FUELS

M. H. MAWHINNEY, SECTION EDITOR

Trends in Open Hearth Engineering. W. Trinks. *Blast Furnace & Steel Plant*, Vol. 22, Aug. 1934, page 463. While automatic control of furnace pressure and fuel-to-air ratio has been in use for several years, it is only quite recently that a method has been developed to vary fuel and air flow continuously so as to maintain maximum safe furnace temperature. This will hasten greatly the general adoption of furnace insulation. Pusher fan (required in fuel-to-air ratio control) may well be made strong enough for the use of correctly designed 2-pass checkers, particularly if mechanical means are available for removing combustion products. Such mechanical means favor installation of waste heat boilers. MS (6)

Development of Controlled-Atmosphere Furnaces and Photoelectric Pyrometers. H. A. Wynne. *Industrial Heating*, Vol. 2, Jan. 1935, pages 25-26, 34. Recent developments and installations of furnaces for scale-free hardening, annealing and copper brazing are described. Ha (6)

Physical Properties of Some Insulating Refractories. W. C. Rueckel. *Blast Furnace & Steel Plant*, Vol. 22, Aug. 1934, pages 476-477. Paper read before the Ohio Ceramic Industries Association. See *Metals & Alloys*, Vol. 5, Aug. 1934, page MA 399. MS (6)

The Development of Furnace Design in Steel and Malleable Foundries (Die Entwicklung des Ofenbaues in Stahl- und Tempergiessereien). P. Rheinländer. *Die Giesserei*, Vol. 21, Nov. 9, 1934, pages 476-480; Nov. 23, 1934, pages 504-507. Modern development caused by the trend to use high-grade remote gas supplies and electric current as heating fuels is reviewed and design details and operating data of melting, core-drying, annealing and malleablizing furnaces are given and compared for different fuels. Ha (6)

Use of Solid and Liquid Fuels (Utilisation des Combustibles solides et des Combustibles liquides). L. Lahoussey & Leduc. *Usine*, Vol. 43, Nov. 22, 1934, pages 35-37. The characteristics of various solid and liquid fuels now mainly used in industrial heating, are discussed with respect to purchasing price, particular advantages of each fuel, and utilization of national domestic supplies as determining factors for their selection in a given case. Discussed with special application to French conditions. Ha (6)

Accurate Temperature Control Essential to Good Steel. W. C. Kernahan. *Heat Treating & Forging*, Vol. 20, Sept. 1934, pages 436-439. Describes heat treating and temperature control equipment in use at the plant of the Timken Steel & Tube Company. Recording potentiometers and automatic temperature controllers are used extensively. There are various types of electric and gas-fired furnaces. MS (6)

Furnace Efficiency Increased by Moll Checkers. P. Stickel. *Blast Furnace & Steel Plant*, Vol. 22, Nov. 1934, pages 635-637. By use of Moll checkers in regenerators, thermal losses can be reduced considerably without addition of a waste-heat boiler or enlargement of the chambers. These checkers possess the advantages of large heating surface and storage capacity and sufficient free horizontal area. Size of the checker, which is essentially an oval-shaped hollow brick, is 12" x 4" x 2". Oval opening is 3¼" x 8". When stacked in a regenerator, flues between the checkers are 4⅜" x 4⅜". Strength is equal to that of a 12" x 4" x 4" checker. Bearing surface is 21.6 in.^{2} Comparison of the checkering of a 150-ton open-hearth furnace in standard 13½" x 4½" x 4½" and in moll checkers shows that with the latter, heating surface is increased 87%, while total weight remains the same, and the free horizontal area is increased about 7%. Preheating temperature of air will be raised about 150°-250° F., waste gases will leave the chambers at 200°-250° F. lower temperature, and melting rate will be increased 10-25%. MS (6)

Furnace for Heating Pipe. J. B. Nealey. *Heat Treating & Forging*, Vol. 20, Aug. 1934, pages 408-409. See "Buttweld Pipe Plant Arranged to Eliminate Backtracking," *Metals & Alloys*, Vol. 5, July 1934, page MA 329 MS (6)

Electric Radiation Furnace with Carbon Resistance (Fours électrique à Rayonnement à Résistance de Carbone). Henri George. *Revue de Fonderie Moderne*, Vol. 28, Dec. 10, 1934, pages 337-342. See *Metals & Alloys*, Vol. 5, Dec. 1934, page MA 567. Ha (6)

Latest Developments in High Frequency Induction Furnaces (Virvelströmugnens senaste utveckling). L. Dreyfus. *Teknisk Tidskrift*, Vol. 64, Oct. 6, 1934, (Section *Elektro-Teknik*) pages 154-160. Paper read before Swedish Society of Electrical Engineers, March 16, 1934. Discusses thoroughly the principles underlying the modern high frequency furnace, and goes into detail in respect to the new German Rohn furnace, drawing comparison with the Swedish Sandviken furnace. Main advantage of the Rohn furnace lies in the violent turbulence of the metal bath. Cites examples of its use in the decarburization of carbon steel, stainless steel, and ferro-chrome. Deals with the importance of the proper shape of the furnace crucible on the economy of operations and cites the advantages of a conical crucible over one with vertical walls. BHS (6)

Current Improvements in Industrial Furnace Construction. H. M. Christman. *Industrial Heating*, Vol. 2, Jan. 1935, pages 23-24, 34. Recent improvements particularly in the direction of saving of weight and mass and consequently in stored heat are discussed and some materials for bricks of diatomaceous nature used in constructing walls are described. Ha (6)

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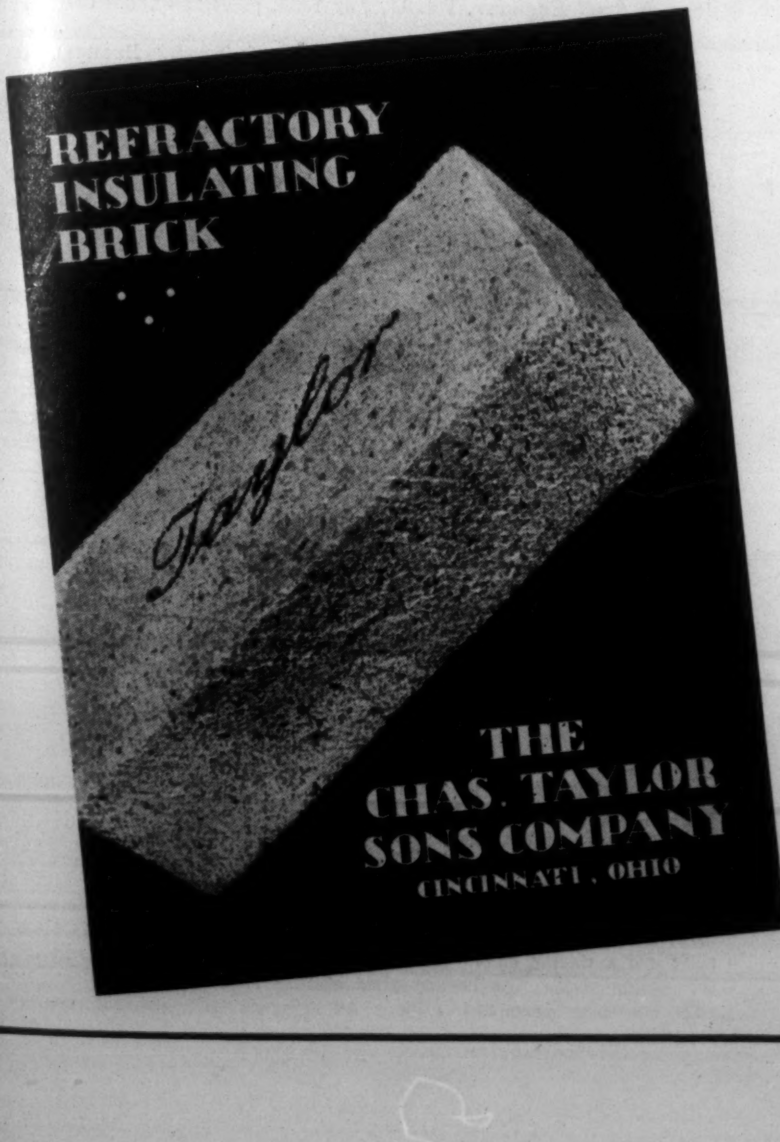

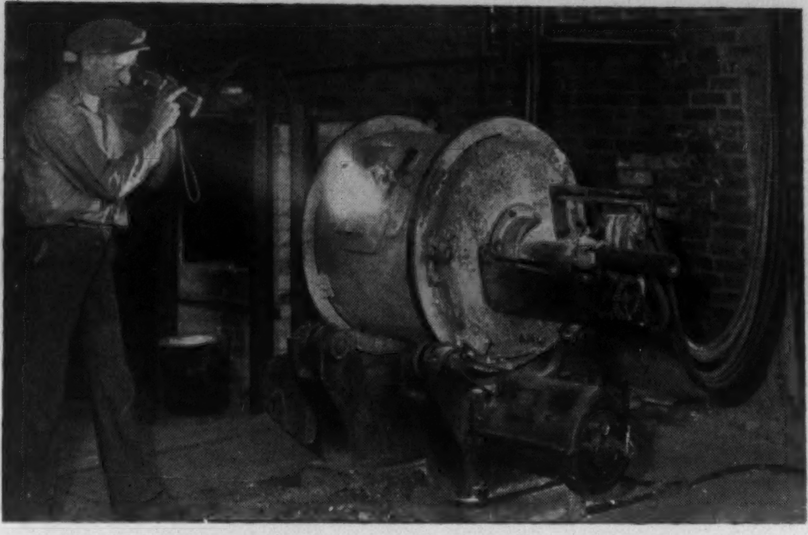

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Further Investigations of Basic Refractories for Steel Melting Furnaces. A. H. B. Cross & W. J. Rees. *Transactions Ceramic Society,* Vol. 33, Oct. 1934, pages 379-443. Mixtures of raw and dead burned Grecian magnesite with kaolin were studied. It is shown that the refractoriness varies considerably with change of composition, reaching a minimum of about 1300° C. for a magnesia content of 32%. Above 50% MgO the refractoriness is 1710° C. The thermal expansion of magnesite is lowered by the addition of kaolin. The typical mineral of all magnesite-kaolin mixtures appears to be cordierite. The spalling resistance of the magnesite-kaolin mixtures was found to increase as the thermal expansion decreased. The addition of kaolin to magnesite increases the range of plastic deformation at high temperature under load, but seriously lowers the resistance to corrosion by basic openhearth- slag and by copper blast-furnace slag. Extension of this work to dolomite-kaolin mixtures shows that the refractoriness is low with less than 50% dolomite. Mixtures containing between 50 and 75% dolomite disintegrate after firing owing to the formation of calcium orthosilicate. Mixtures containing 80 to 90% dolomite are interesting as refractories and resist hydration very well. GTM (6)

Possibilities of Off-Peak Heat Storage in Furnaces. A. E. Bellis. *Industrial Heating,* Dec. 1934, pages 177-180. The economy to be obtained by storing heat in liquid bath furnaces which are heated during night and noon period at favorable power rates is pointed out and illustrated by examples. Ha (6)

Improving Wire Annealing Equipment. Theo. B. Bechtel. *Heat Treating & Forging,* Vol. 20, Aug. 1934, pages 406-407. Use of recently developed equipment for annealing low-C steel wire resulted in greatly reduced fuel consumption, low annealing time, and uniformity of product. Consists of fuel-fired pit-type furnace proper, 4 heat-resisting light alloy pots, 2 cooling holes, and 2 preheating holes. Pot and charge are independently supported. Unit has a capacity of 250-300 tons per month of continuous operation. It occupies practically the same amount of floor space as one of the old type pits. Typical charge of 6000 lb. of 13½-gage wire, annealed dead soft for redrawing, requires 8 hrs. heating time in the furnace with a furnace temperature of 1350° F. and fuel consumption of 2,000,000 B.t.u. or less per ton. Original pots are still in service after almost 3 years of practically continuous operation. Equipment is used also for bright annealing of steel wire, annealing of Cu and bronze wires, and normalizing and spheroidizing of steel rods. MS (6)

Fuel-fired Furnace Temperature and Atmosphere Control. G. H. Barker. *Metallurgia,* Vol. 11, Dec. 1934, pages 29-32. Compares advantages of manual and automatic control. Different mechanical controls are described. JLG (6)

Efficiency of the Cupola Furnace (Note sul Rendimento del Cubilotto). M. Barigozzi. *Industria Meccanica,* Vol. 16, Sept. 1934, pages 758-765. Definition, methods of determining, and factors influencing the efficiency of a cupola furnace are critically reviewed. A final formula for calculating the efficiency is derived: $\eta = (0.002547T + 0.303)/aK$, where T is the temperature centigrade at the iron runner (tap hole), a is the content of C in % in coke, and K the coke charge in kg. Making up a heat balance and application of the formula for different operating conditions are illustrated by examples. 7 references. Ha (6)

Gas Uses in Cylindrical Roller Bearing Factory. Ralph Manier. *American Gas Journal,* Vol. 141, Oct. 1934, pages 9-10. Furnaces used in the heat-treatment of S.A.E. 52100 steels at the Railway Roller Bearing Co. are discussed. CBJ (6)

Characteristics of Temperature Controls for Oil Fired Furnaces. W. N. Horko. *Iron & Steel Engineer,* Vol. 11, July 1934, pages 266-269. General. WLC (6)

Utilization of Batch Furnace for Heating. T. B. Bechtel & M. H. Mawhinney. *Iron & Steel Engineer,* Vol. 11, July 1934, pages 245-248. WLC (6)

Development of the Submerged Resistor Induction Furnace. G. H. Clamer. *Metals & Alloys,* Vol. 5, Nov. 1934, pages 242-250. Describes the development of Ajax-Wyatt furnace and its present applications as a melting tool. WLC (6)

Tomorrow's Industrial Furnaces to Have Insulating Refractories. H. M. Christman. *Iron Age,* Vol. 133, June 14, 1934, pages 25-27. From a paper read before the Detroit Chapter of the American Ceramic Society. Predicts that furnaces of the future will be light weight and more or less portable. They will have refractory heat insulation and heat loss will be minimized. VSP (6)

Some of the Uses of Electric Resistance Furnaces in Industry (Quelques emplois du four eléctrique à resistances dans industrie). *Journal du Four Electrique,* Vol. 43, Aug. 1934, pages 282-290; Sept. 1934, pages 327-329. Brief description of industrial resistance furnaces largely of German manufacture. JDG (6)

Top Firing by Gas of Galvanizing Pots. *Iron Age,* Vol. 133, Apr. 19, 1934, page 78. Brief description of method used at plant of Oliver Iron and Steel Corpn., Pittsburgh. VSP (6)

Latest Improvements in Electric Melting Furnaces (Les derniers perféctionnements aux fours électriques de fusion). M. Vastel. *Journal du Four Electrique,* Vol. 43, Oct. 1934, pages 364-369; Nov. 1934, pages 396-401. Mechanical characteristics and the theory of the accessories used with Heroult electric furnaces are described. JDG (6)

Determination of the Heat Conductivity of Ceramic Materials at High Temperature (Bestämning av värmeledningsförmaagan hos keramiskt material vid hög temperatur). Bertil Staalhane & Sven Pyk. *Teknisk Tidskrift,* Vol. 64, Dec. 1, 1934, pages 445-448. Describes an apparatus for measuring the heat conductivity of brick and other ceramic materials at temperatures up to 1100°-1200° C. The measurement is based on parallel flow of heat through a sample piece imbedded in a suitable medium, such as coarsely crushed quartz, between an electric heating plate and a cooling plate. The heat effect is measured in a calorimeter placed in the cooling plate. The heating plate consists of a kanthal resistance imbedded in pure crystalline aluminum oxide. An accuracy of ±5% is claimed for the apparatus. BHS (6)

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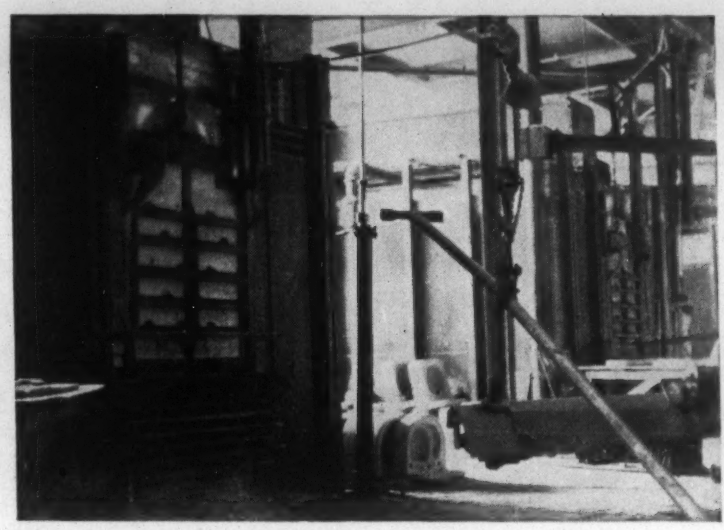

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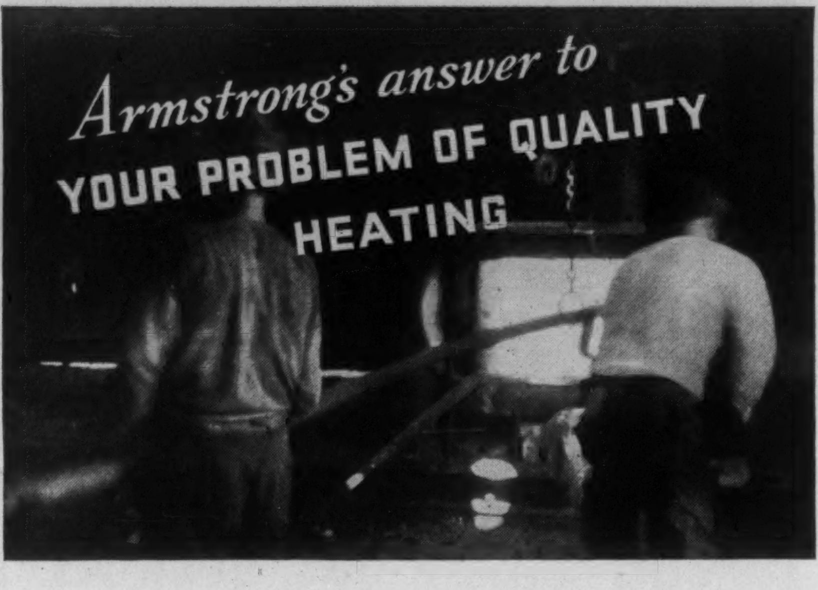
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Heating by Induction in Metallurgy (Le Chauffage par Induction en Métallurgie). P. BUNET. *Usine,* Vol. 43, Dec. 20, 1934, pages 31-34. Various types of induction furnaces and melting methods are described. The overall efficiency of such furnaces is about 50%, i.e. to melt 1 kg. Fe from cold state about 0.75 kw.hr. are required instead of the theoretical 0.38 kw.hr. Recent furnaces will stand 1200 melts. Ha (6)

Behavior of Fireclay to the Action of Carbon Monoxide. P. BUDNIKOV & D. NIRENSHTEIN. *Stahl,* Vol. 4, July, 1934, pages 48-52. In Russian. Fireclay brick are rapidly disintegrated at a temperature of 450°-500° by C deposited in the pores by the reaction $2\,CO \rightarrow CO_2 + C$. The presence of 1-5% FeO in the brick acts as a catalyst for this reaction, thereby greatly increasing the rate of disintegration. The addition of a small amt. of $CuSO_4$ to the fireclay hinders disintegration. HWR (6)

Pulverized-Fuel Melting Furnace. *Heat Treating & Forging,* Vol. 20, June 1934, page 305. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 566. MS (6)

Refractory, Heat-Resisting Concretes Show Stamina in Furnace Uses. *Steel,* Vol. 95, Oct. 8, 1934, pages 29-32. Heat-resisting concrete, incorporating Al_2O_3 cement, is very efficient for furnace foundations and floors exposed to heat, in addition to its strictly refractory uses in industrial furnaces. MS (6)

Gas Heating in Making Chevrolet Knee-Action Springs. *Iron Age,* Vol. 134, Sept. 13, 1934, pages 26-28. Describes gas furnaces and methods of heat treating knee-action springs at plant of Chevrolet Motor Co. This article supplements the one published in *Iron Age,* Mar. 1, 1934, on methods of making knee-action units. VSP (6)

Time Required for Heating Steel. J. D. KELLER. *Heat Treating & Forging,* Vol. 20, Oct. 1934, pages 487-490. Mathematical derivation of formulae and curves used by author in the Nov.-Dec. 1933 issues. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 138. MS (6)

Heating for Forging. J. B. NEALEY. *Heat Treating & Forging,* Vol. 20, Oct. 1934, pages 479-481. **Gas Heating for Forging Furnaces.** *Iron Age,* Vol. 134, Nov. 1, 1934, pages 23-24. **New Type Diffusion Burners Used on Gas-Fired Forging Furnaces.** *Steel,* Vol. 95, Oct. 15, 1934, pages 29-31. Describes furnaces at the plant of the Transue & Williams Co., Alliance, O. Oil furnaces are being converted to gas firing. Some of the furnaces are equipped with a modified diffusion burner, by means of which the different strata are projected at different velocities. Basis for this is that there is a direct relation between the ignition velocity of the constituents of the heating gases and the applied velocities of the various strata by which the rate of diffusion and the radiant heat emissivity can be controlled. In practice, gas and air are introduced through the burner into the furnace at the same pressure, the smaller size of the gas orifice giving the gas the greater velocity. Other furnaces use older types of nozzle mixing and inspirator type gas-burners. MS + VSP (6)

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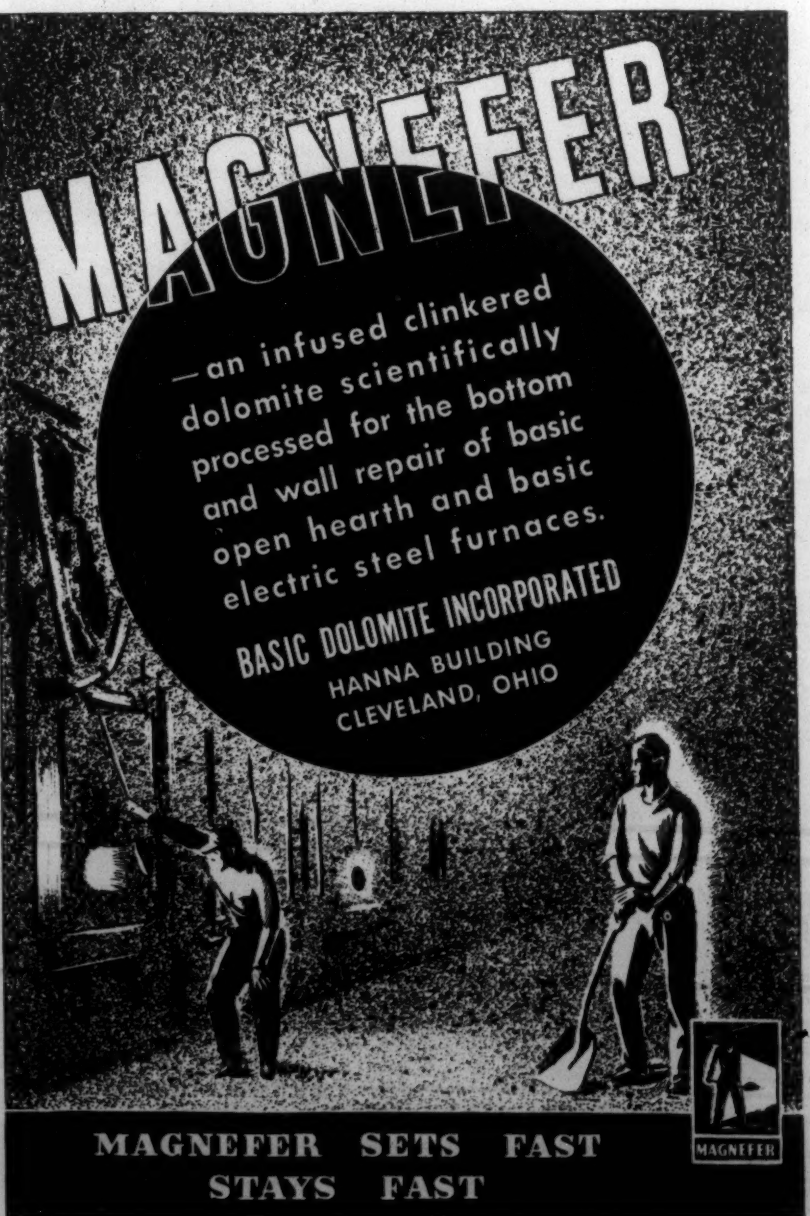
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STAYS FAST

7. JOINING

Welding and Soldering of Heat Resistant Austenitic Steel Sheets (Schweissen und Löten austenitischer Stahlbleche). Herbert Herrmann. *Feuerungstechnik,* Vol. 22, Feb. 15, 1934, pages 23-24. Austenitic steels with 16-25% Cr, 7-15% Ni, 0.3-2.5% Si and 0.05-0.15% C can be gas and electrically welded. Cr losses amount to 1-2% (volatilization) and 0.5% Ni are oxidized and absorbed in the weld. A short arc and coated electrodes which contain 19 Cr and 8.5 Ni for 18/8 should be utilized. Ni oxide can be partly removed by alcoholic borax (60-75 borax) -boric acid (40-25 boric acid + additions of $ZnCl_2$) pastes. Oxy-acetylene welding involves smaller Cr and Ni losses. However C is introduced into the weld by acetylene if the torch is not strictly neutral. O_2 excess leads to scorification of Ni. Due to its low thermal conductivity, considerable heat stresses are set up in welding austenitic Cr-Ni steels. Due to shorter welding times, electric welding is supposed to have an edge over gas welding. It is, however, claimed by some welding experts, that gas welding furnishes superior welds due to a softer and cooler flame and a uniform heat dissipation. The latter can be aided by Cu bars or sheets. Clamping is not advisable. Heat stresses are released by annealing the work after the weld is hammered. Soldering can be applied if the service temperature does not exceed 250°-300° C. Only Ag solders (12-15% Ag, balance Cu and Zn) are suitable. Up to 3% Ni are said to raise corrosion and heat resistance of the solder and to prevent grain growth. Very pure metals must be used for making the Ag solder. The soldering temperature must be above 850° C. preferably 900°-920° C. EF (7)

Bonding Strength of Babbitt to Steel and Bronze. E. G. Soash. Extended Abstract by H. W. Gillett. *Metals & Alloys,* Vol. 5, Dec. 1934, page 268. Reports work on effect of surface preparation on the bond between babbitt bearings and their backing. The bond is substantially improved by proper cleaning and tinning of the surface and then quickly casting on the babbitt. Under best practice the bond obtained on steel was 7,000 lbs./in.² and on bronze (Cu 88, Sn 7, Zn 3, and Pb 2) 13,000 lbs./in.² WLC (7)

7b. Welding & Cutting

C. A. McCUNE, SECTION EDITOR

The Principles and Applications of Electric Arc Welding to Large Structures. R. G. Griffin. *Commonwealth Engineer,* Vol. 21, Apr. 2, 1934, pages 259-267; May 1, 1934, pages 297-300. Paper before the Institution of Civil Engineers, Sydney, Feb. 1934. Electric arc welding possesses considerable advantages for application in steel structural work on account of reduction of cost and because it permits better disposition of the material for carrying the load than where riveted joints are used. The principal difficulties encountered are control of the quality of the deposited metal, distortion and the variable human element. The speaker discusses the problems of welded construction, particularly weld and parent metal, type of joints and structural design. Nature and micro-structure of the metal forming the joint region are taken up at great length under metallurgical viewpoints. The strengths and general characteristics of various types of joints are dealt with and the salient points brought out with the aid of rubber models showing that the maximum advantages of welded constructions are obtained with the minimum amount of welding. The balance of the paper considers factors that must be taken into account in the design of welded structures dealing with secondary stresses, section of members, and design of joints. It is shown that the stresses cannot possibly be proportional to the apparent strains in distorted specimens. WH (7b)

How Must Aluminum Vessels for Transport and Storage of Nitric Acid Be Welded (Wie sollen Aluminiumbehälter für Transport und Lagerung von Salpetersäure geschweisst werden)? G. Eckert. *Aluminium,* Vol. 17, Oct. 1934, pages 84-88. Experiments with various types of welded vessels lead to the conclusion that only fusion welded Al vessels should be used in the nitric acid industry; the seams must be well annealed and may be slightly hammered afterwards. The seams must under no circumstances be left in the welded condition or roughly hammered. If annealed with the welding flame local overheating should be avoided. Ha (7b)

Coefficient of Efficiency of the Welding Flame. N. S. Elistratov. *Welding (Autogennoie Delo),* No. 8, 1934, pages 7-10. In Russian. The loss of heat during welding is due to radiation, heat conductivity and convection. Calculations show that the greatest amount of loss of heat during welding is due to heat radiation. The heat (Q) radiated by the area of 1 m.² during welding carried out in an open space may be expressed by the following formula:

$$Q = 4\left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right]\frac{\text{Cal.}}{\text{m.}^2/\text{hr.}}$$

where T_1 is absolute temperature of radiating body and T_2 is absolute temperature of the surrounding atmosphere. In order to increase efficiency of the welding flame it is necessary to bring all losses of its heat to a minimum. It is necessary to carry on the welding process in an enclosure to reduce the heat losses by convection. Welding should be carried out as quickly as possible in order to decrease the heat losses due to heat conductivity. Special shields concentrating heat radiation on the weld are useful particularly in the case of automatic welding. AIK (7b)

The Restoration of Old Loading Bridges by Means of Electric Welding. *Welder,* Vol. 6, Oct. 1934, pages 328-329. Modernization of a 30-year old slewing-crane installation of 12 m. radius and a bridge of 73 m. length by electric welding is described and illustrated. Ha (7b)

Hungarian Specifications on Welded Structures (Die ungarischen Vorschriften für geschweisste Stahlhochbauten). Bela Enyedi. *Die Elektroschweissung,* Vol. 5, Nov. 1934, pages 211-212. In principle these Hungarian specifications are in agreement with the new German specifications D I N 4100. Author considers points of the Hungarian specifications that deviate from the German ones. These deviations refer to (1) calculation of channeled seams, (2) permissible loading of such seams, and (3) dimension of samples for mechanical tests. As regards (2) the shear stresses permitted are much lower than those permitted by the German specifications, the loads permitted in tension and compression, however, are higher. In overhead welding the stress must be lowered to 60% and in welding crane beams to 70% of the load. GN (7b)

Spot Welding. L. Ferguson. *Bell Laboratory Record,* Vol. 13, Dec. 1934, pages 109-112. Principles of spot welding are briefly explained and a diagram drawn up which shows for 24 metals and alloys what kind of weld can be made with a combination of any 2 metals; distinction is made between good welds, completely miscible but brittle welds, poor welds and no welds. A few special applications in the manufacture of telephone apparatus are described. Ha (7b)

Maintenance of Rolling Stock and Rails by Welding (L'Entretien par Soudure du Matériel Roulant et des Voies Ferrées). Rochette de Lempdes. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 5, Aug.-Oct. 1934, pages 1431-1448. Lecture before the French Welders' Society. Author takes some of his data from the papers read at the last International Welding Congress of Rome. FR (7b)

Arc Welding in Railroad Maintenance. A. M. Candy. *Railroad Engineering & Maintenance,* Vol. 30, May 1934, pages 275-277. A discussion of the equipment characteristics that produce the greatest efficiency in the application of arc-welding to repair problems on railroads. Discussed are: constant current through arc, simple control of welding current, capacity of equipment, auxiliary power for grinders, operation of the equipment, effect of increasing length of circuit, portability of apparatus, application of equipment, repairing special trackwork. The total cost of maintaining 8 Mn steel crossings in a double-track main line intersection is given as 20% of the initial costs. WH (7b)

Your Welding—Are You Getting the Most From It? Charles Wise. *Railway Engineering & Maintenance,* Vol. 30, Aug. 1934, pages 429-430. Describes the practice of building-up and repairing switch points, frogs and rail ends at the Proviso yard of the Chicago & Northwestern. Building up the point of switches too high and the presence of a lip on the side of the ball of the stock rail lead to defects. A rod of softer steel should be used for the last 6 inches of the switch point. A final coat of harder steel and "mixing" both by vigorous hammering furnishes the proper degree of toughness. Straightening of bent switch points, welding of self-guarded frogs, reclaiming of bent and broken frogs is considered. Advises butt welding of rails on bridges to reduce cost of upkeep. The importance of the grinder due to increased output of the welding gang is stressed. WH (7b)

Arc Welding By the Metallic Electrode Process. H. Thomasson. *Canadian Chemistry & Metallurgy,* Vol. 18, Dec. 1934, pages 280-282. An abstract dealing with heavy coated vs. bare rods, corrosion-resistance of welds, tensile testing, deposit ratio and arcing times at various ampere ratings, length of weld from various electrodes, and depth of fusion. A rapid low-cost shop test that reveals the type and soundness of the metal being deposited is described. A weld is made between two pieces of plate of any size and shape as long as one has a straight edge to form the corner for a fillet weld. The weld is broken by sledge hammer blows and defects are exposed through any flaws in the weld. Tables show: a comparison of the physical characteristics of mild steel deposited by the metallic arc welding process, the deposit ratio and arcing times at various ampere ratings and arc welding data on no. of inches of fillet welds to be obtained from one electrode. WHB (7b)

Mass Production and Projection Point Welding (Massenanfertigung und Projektions- Punktschweissung). Paul A. Schmatz. *Die Elektroschweissung,* Vol. 5, Nov. 1934, pages 204-210. Paper first discusses principles underlying single point welding, multiple point welding and projection point welding, the highest perfection of welding in this particular branch. The most essential advantage of projection point welding is saving in welding time. The shortened welding time offers the further advantage that the welding current is concentrated upon the section to be welded so that the adjacent areas remain cold thus avoiding distortion of work piece, increasing the heat efficiency of the process and saving electrode material. The principles outlined are then illustrated for the practical example of welding automobile brake shoes. By projection point welding about 162 pieces could be made per hr. whereas by single point welding only 34 pieces could be welded in that time. The current costs were alike in both cases. Modern projection point welding machines, the construction of which fundamentally differs from single point welding machines, and their mode of operation are described. GN (7b)

An Entirely Welded Signal Overhead Structure in the Railway Station of Reims (Une Passerelle à Signaux Entièrement Soudée en Gare de Reims). M. Schmid. *Bulletin de la Société des Ingénieurs Soudeurs,* Vol. 5, Aug.-Oct. 1934, pages 1449-1455. Lecture before the French Welders' Society. Illustration of the work and details of manufacture are given. FR (7b)

The Electric Welder of Today (Der Elektroschweisser von heute. Eine Streife durch die Praxis). H. Schäfer. *Die Elektroschweissung,* Vol. 5, Nov. 1934, pages 212-213. Author gives practical hints for the training of welders. GN (7b)

Better Welding Rod Means Better Welded Joints. J. H. CRITCHETT. *Metal Progress,* Vol. 27, Jan. 1935, pages 27-30. Part of a discussion at 35th Convention International Acetylene Association. Improved weld metal has been obtained by incorporating in rod the essential constituents necessary to produce high grade steel and use of a carburizing flame to prevent formation of iron oxide or its reduction when formed to make a solid dense metal deposit. WLC (7b)

Welding as a Factor in Railway Rolling Stock Construction in Poland. A. BRANDT. *Welder,* Vol. 6, Oct. 1934, pages 346-349, 351. Welding methods and designs for freight cars and passenger coaches snow ploughs, etc., are briefly described and illustrated. Ha (7b)

Welding Rod Coatings. L. B. BLISS. *Iron Age,* Vol. 134, July 26, 1934, pages 30-32. See *Metals & Alloys,* Vol. 6, Jan 1935, page MA 18. VSP (7b)

Prefabricated Welded Frame Panels Used in Dormitory. PHILIP I. BAKER. *Steel,* Vol. 95, Oct. 29, 1934, pages 37-39. Describes steel frame construction of dormitory at Stanford University. Wall and floor systems all were fabricated from light hot-rolled members, and all connections were arc welded. Provides fire safety, earthquake resistance, permanence, and freedom from shrinkage. MS (7b)

Suppression of Hard Spots and Blow Holes in Welds on Cast Iron (Suppression des Grains Durs et des Soufflures dans la Soudure des Pièces de Fonte). A. BAILLON. *Revue de la Soudure Autogène,* Vol. 26, Oct. 1934, pages 6-9. Paper read at the 11th Congress of Acetylene and Fusion Welding in Rome, June 5-10th, 1934. FR (7b)

Regulations Relating to the Erection of Welded Structures in Poland. BRYLA. *Welder,* Vol. 6, Oct. 1934, pages 322-323. Polish rules are reviewed briefly and compared with those of other countries. They are based on a permissible basic tensile stress of 1200 kg./cm.^{2} for structural material and these figures are multiplied by k/1200 for other stresses (values for k are not given). Ha (7b)

Building Up of Rails. Study of Deposited Metal (Rechargement de Voies Ferrées. Etude du Métal Déposé). M. BRUNETEAU. *Revue de la Soudure Autogène,* Vol. 26, Sept. 1934, pages 8-12. Paper read at the 11th Congress of Acetylene and Fusion Welding in Rome June 5-10. FR (7b)

Welded Coach Construction on the Chicago, Milwaukee and St. Paul Railroad. *Engineering,* Vol. 138, Oct. 19, 1934, pages 426-427. Illustrated article. LFM (7b)

Arc-Welded Building at Messrs. Brown, Bayley's Works. *Engineering,* Vol. 138, Oct. 19, 1934, pages 407-409. Illustrated article describing building erection. LFM (7b)

Giant Bliss Press Fabricated by Welding. *Iron Age,* Vol. 134, Aug. 9, 1934, pages 30-31. Describes welding of Bliss-Marquette forming presses by the Westinghouse Electric & Mfg Co. for the E. W. Bliss Co., Toledo. The press is to be used for forming automobile and truck frame side rails. Carnegie Steel Co. welding quality plate was used for the presses. All parts under stress were welded with heavily-coated electrodes. Joints were previously chamfered and close fitted. Welded bed and crown were stress-relieved in suitable furnace to remove internal strains due to local temperature differences. VSP (7b)

Distillation Equipment Built of Arc Welded Aluminum. *Iron Age,* Vol. 134, Sept. 6, 1934, pages 23, 84. Describes the construction of arc welded Al distillation equipment for a new chemical process by the Thornton Co., Cleveland. The still is 7 ft. 4 in. high and 3 ft. 6 in. in diam. It is made of ⅝" Al welded with longitudinal seam, edges of plate being vee'd out before welding. Bottom is a dished plate. Top is bolted on by means of 4" x 4¾" arches, which are lap-welded to body of still and to top. VSP (7b)

Gives Welding Properties of Metal Combinations. *Machine Design,* Vol. 7, Jan. 1935, page 32. A chart is presented showing the welding characteristics of 250 combinations of metals recently tested by the Bell Telephone Laboratories for possibilities of spot welding. The key to the symbols differentiates between good weld, completely miscible but brittle weld, poor weld, no weld and combination not tried. The original chart, into which the great number of tests have been condensed in a very clear fashion, must be consulted for further details. WH (7b)

A User's Viewpoint on Welding and Casting. *Machine Design,* Vol. 7, Jan. 1935, pages 33-36. Discusses the intelligent selection of cast or welded structure in the development of machinery largely referring to practical experience of Einstein and Chapman. Points out that the elimination of the necessity of a pattern is the foremost advantage of the welded over the cast structure. The pattern cost becomes negligible in mass production work. The welding department requires simpler equipment. A few practical examples are illustrated and discussed in full detail. It is assumed that where 5 or more pieces of a small or medium size part can be made of a pattern, the cast structure is economically preferable over the steel structure. However in machines where strains and stresses are important factors (shears, brakes, punch presses) the welded structure will in time be the universal structure used even if the machines are manufactured in quantities. Similarly in cases where large quantities are used on parts of somewhat simple design (tanks, guards) the welded structure might be the structure of the future. Some of the abuses of welded joints that detract from the efficiency of a welded structure are discussed critically. WH (7b)

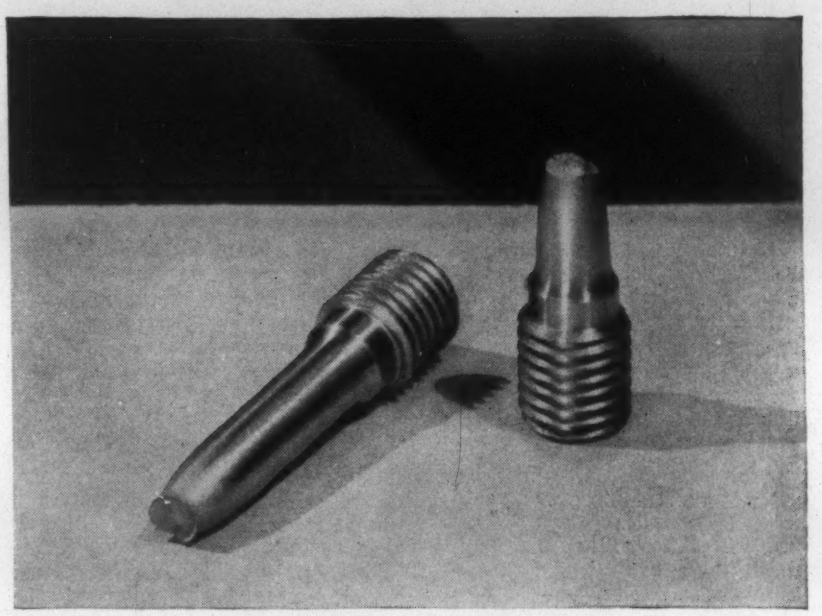
German and American Welding Specifications (Vereeniging voor Laschtechniek. Voorschriften van de Deutsche Reichsbahn Gesellschaft voor de levering van autogeen- en electrisch laschdraad voor verbindings- en opdiklaschen). *Polytechnisch Weekblad,* Vol. 28, June 28, 1934, pages 409-410. **(Voorloopige eischen van de American Welding Society voor laschmateriaal).** *Polytechnisch Weekblad,* Vol. 28, July 12, 1934, pages 441-442. The first paper tabulates the new German specifications of the Reichsbahn for filler rod material (analyses given) and for the physical properties of gas and electrically welded joints. The second paper covers the modifications of June 1, 1933, of the American Welding Society's welding code. WH (7b)

NICKEL STEEL

Steels containing nickel have high tensile strengths and resistance to shock. The most common of these steels contain from 2% to 3½% nickel and possess physical properties varying with the carbon content. An outstanding characteristic of the lower carbon nickel steels is their high impact value at low temperatures.

MUREX NICKEL STEEL

WELD METAL



PHYSICAL PROPERTIES

Yield Point ....72,000 p.s.i. Elongation in 2 in. 25.5%
Ultimate Strength ...86,000 p.s.i. Reduction in Area 64%

CHEMICAL ANALYSIS

Carbon .... .08% Manganese .... .54%
Silicon .... .08% Molybdenum .... .29%
Nickel 2.30%

Murex Nickel Steel Electrodes are used extensively in the fabrication of dry ice storage tanks, wax filters for petroleum refineries and other vessels for high pressure-low temperature service made of lower carbon nickel steels. At 75° below zero, Fahrenheit, the Murex all weld metal nickel steel deposit shows Charpy impact values of 20 to 24 ft. lbs. These electrodes are also used in welding silicon-killed steels, high carbon steels and the higher carbon nickel steels, in fact, wherever a combination of high tensile strength and exceptional ductility is demanded.

Murex Electrodes for welding alloy steels . . . including Carbon-Molybdenum .50, Carbon-Molybdenum .80, Cromansil Steel, 2½% Nickel, .85% Nickel, 4% to 6% Chrome . . . have found wide acceptance throughout industry. All are standard Murex Electrodes and can be furnished promptly from stock.

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Nitrogen in Metallic Arc Weld Metal. J. W. Miller. *Iron & Steel Engineer,* Vol. 11, Nov. 1934, pages 450-462. See "A Study of Nitrogen in Metallic Arc Welding," *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 570. WLC (7b)

Principles and Design of Welded Structures I, II, III. D. V. Isaacs. *Commonwealth Engineer,* Vol. 21, May 1, 1934, pages 291-296; July 2, 1934, pages 387-391; Vol. 22, Aug. 1, 1934, pages 18-22. The application of electric welding to steel construction work has given rise to a need for development of new technique for design of structures as well as their fabrication. Following upon intensive study of the physical properties of welded joints, definite principles have been worked out which govern the design of welded bridges and building structures. By the aid of numerous examples, it is explained how the designs may be worked out for various component parts of the structure. The series of articles deals with buildings under the subheadings column bases, columns, column splices, support of floor beams and joists, (reference is also made to the construction of battledeck steel flooring) plate girders, roof trusses and bridge and building trusses. WH (7b)

Modern Oxy-Acetylene Production Welding. C. Helsby. *Journal Institution of Production Engineers,* Vol. 13, Aug. 1934, pages 431-458. Includes discussion. Deals generally with approved practice in the oxy-acetylene welding of mild steel, with the strength of welds, and typical applications. It is recommended that butt welds, made by the Rightward method be used whenever possible. Fillet welding requires more skill. A table for calculating the strength of fillet welds is given. JCC (7b)

Electric Welded Steel Structures. Ewart S. Andrews. *Gas Engineer,* Vol. 59, Aug. 1934, pages 455-456. Reviews the new British Standard Specification No. 538 for Metal Arc Welding as Applied to Steel Structures. Working stresses in butt welds are specified as 85% of the permissible working stress in the parent metal for tension and shear and 100% for compression. In the case of fillet welds measured on the throat area the permissible stress is given as 6 ton/in.^{2} for end fillets and 5 ton/in.^{2} for side fillets. The author fears that 5-6 years may elapse until the unreasonable Clause 32 in the B.S.S. No. 449 for the Use of Structural Steel in Building will be abolished. This clause says that "either rivets or turned bolts of driving fit shall be used for all fabrication work at works." WH (7b)

Effect of Composition of Welded Material on the Density of the Weld (Vereeniging voor Laschtechniek. Invloed van de samenstelling van het werkstukmateriaal op de dichtheid van de lasch). *Polytechnisch Weekblad,* Vol. 28, May 24, 1934, pages 330-331. Mainly refers to investigations of Leitner on weld porosity which was found to be (1) accentuated by high welding speeds, rapid solidification, low Si bearing material and (2) counteracted by high current intensities, higher Mn (1.7%), higher Si (.6%) and higher C (.4%) contents. WH (7b)

Electric Arc Welding Saves 40 Year Old Viaduct. *Railway Engineering & Maintenance,* Vol. 30, Aug. 1934, pages 432-436. Article deals with the manner in which the electric arc process was employed in strengthening and repairing an old structure at relatively low cost. A number of special problems were imposed in correcting defects resulting from faulty details in the old design. WH (7b)

Welding Details of Milwaukee Coaches. *Railway Mechanical Engineer,* Vol. 108, Dec. 1934, pages 444-446. Illustrated details of design and welding procedure of the C.M.St.P. &P. railroad. Ha (7b)

Repair by Oxy-Acetylene Welding of Aluminum Alloy Crankcases (La Réparation par Soudure Oxy-Acétylénique des Carters en Alliages d'Aluminium). *Revue de la Soudure Autogène,* Vol. 26, Nov. 1934, pages 2-4. This very special work shows many difficulties. Composition of metal differs considerably from one casting to another because mixtures are often made with old crankcases of unknown composition. It is necessary to clean the casting before repair. Before welding, castings must be preheated in a furnace whose temperature can be controlled because alloys have a low melting point. Repairer must be able to cast or shape missing parts. When parts to be repaired are not accessible it may be necessary to cut the crankcase and to weld it over again. FR (7b)

Repairs of Iron Casting by Arc Welding (Les Réparations de Pièces de Fonte à l'Arc Electrique). *Revue de la Soudure Autogène,* Vol. 26, Nov. 1934, page 11. For repairing cast Fe by arc welding, 2 methods are available: (1) use of cast Fe rods as added metal, in this case, it is necessary to preheat the casting because arc can be kept up at high temperature only. (2) Use of soft steel or cupro-nickel rods as added metal, in this case, the casting must be maintained cold during all the operation. With the latter methods, edges of the fracture are beveled and steel studs are screwed into the bevel surface. Application of the second method is illustrated for the repair of large Diesel motor frame. FR (7b)

Welding—The Modern Method of Production. P. L. Roberts. *Journal Institution of Production Engineers,* Vol. 13, Oct. 1934, pages 517-526. Includes discussion. Examples are given of the use of welding as a manufacturing process. Advantages are saving in cost and time, universality, and simplicity. JCC (7b)

Evolution of the Arcronograph. Bela Ronay. *Engineer,* Vol. 158, Sept. 21, 1934, pages 295-296. From paper appearing in the Aug. 1934 number of the *Journal of the American Society of Naval Engineers.* LFM (7b)

Suitability, Safety and Simplicity of Electrically Welded Constructions (Zweckdienlichkeit, Sicherheit und Stilreinheit elektrisch geschweisster Konstruktionen). Kurt Ruppin. *Elektrizitätswirtschaft,* Vol. 33, Nov. 5, 1934, pages 458-461. Endeavors "to demonstrate to the designer, architect and contractor the flexibility in the design due to the adoption of welding with particular reference to those cases where the joining of structural members involves great difficulties." Among the 9 representative examples discussed and illustrated the most noteworthy are the welding of a 75 ton all-welded buggy of a crane, airplane catapult, motorboat, railway switch station and slewing crane. WH (7b)

8. FINISHING

H. S. RAWDON, SECTION EDITOR

Product Appearance Builds Sales. R. L. Davis. *Electrical Manufacturing,* Vol. 13, July 1934, pages 14-15, 38. Plating, laquering and enamelling of parts before assembly described. Preparation of material before finishing discussed. WB (8)

8a. Pickling

Modern Strip Pickling Equipment. H. E. Fritz. *Iron Age,* Vol. 134, Sept. 6, 1934, pages 36-37, 96. **New Continuous Pickling Unit Designed for 72-inch Wide Strip Steel.** *Steel,* Vol. 95, Sept. 10, 1934, pages 23-25, 42. Discusses pickling equipment at Inland Steel Co., Indiana Harbor, capable of handling strips up to 72 in. wide. There are 4 steel acid tanks 60 ft. long, 8 ft. 7 in. wide and 4 ft. 4 in. deep, (approx.) lined with Triflex rubber (¼ inch) together with 8 in. sheathing (2 courses) of acid-resisting brick laid in a cement known as "Vitrobond." Provisions have been made for effective fume removal. Special acid sewers were designed to eliminate damage from acid seepage. The unit has served very satisfactorily and at low cost during the 2 years of operation. VSP + MS (8a)

New D. C. Control For Continuous Pickling. R. M. Bayle. *Iron Age,* Voy. 134, Aug. 16, 1934, pages 22-24. Describes new direct current continuous pickling in new wide strip mill of Inland Steel Co., Indiana Harbor. VSP (8a)

Rational Control in Pickling Iron and Steel Components. P. Mabb. *Machinery,* London, Vol. 45, Oct. 4, 1934, pages 9-12. Pickling classification made on the basis of (1) types of iron and steel (2) extent of rust or scale (3) surface finish desired. Pickling solutions of HCl and H_2SO_4 tested for various concentrations with inhibitors. Pickling of castings, high carbon and stainless steels treated from practical angle. WB (8a)

8b. Cleaning, including Sand Blasting

Treatment of Al in the Household (Die Behandlung des Aluminiums in Haushalt). Nicolini. *Aluminium,* Vol. 17, Sept. 1934, pages 34-36. Instructions for cleaning and polishing household appliances are given together with recommended cleansing agents which do not scratch or otherwise injure the surfaces. Ha (8b)

Hidden Sources of Defects in Degreasing of Metals (Versteckte Fehlerquellen bei der Metallentfettung). Richard Justh. *Metallwaren Industrie & Galvano Technik,* Vol. 32, Jan. 15, 1934, pages 27-28. See *Metals & Alloys,* Vol. 5, Apr. 1934, page MA 143. EF (8b)

8c. Polishing & Grinding

Grinding Corrugations out of Rail. *Railway Engineering & Maintenance,* Vol. 30, Sept. 1934, pages 472-475. In April 1934, Lehigh Valley placed in service what is believed to be the first car designed by a steam railway to remove corrugations from rail heads. The car is pulled over the track at high speed (40-50 miles/hr.) and by a series of fixed grinding blocks held in contact with the rail head, abrades the head continuously in successive places. From 4 to 9 track miles of rails can be treated per day. Other surface imperfections, especially at rail ends where batter has been overcome by welding are removed. The depth of the rail corrugations ranges from .002" to .010" (and more). WH (8c)

8d. Electroplating

Nickel Plating of Aluminum Sheet Parts (Zur Vernickelung von Aluminiumblechteilen). Robert J. Snelling. *Metallwaren Industrie & Galvano Technik,* Vol. 32, Jan. 15, 1934, pages 28-29. Two fundamental difficulties arise during Ni plating of Al: (1) instantaneous film formation on Al in the atmosphere, (2) formation of a deposit immediately on immersion in the salt solution due to the place of Al in the electromotive series. Use of water-free solutions for cleaning and metal-containing solutions for pickling will remedy (1) and matting of the surface will counteract (2). Data on bath compositions, temperature, current density, duration of plating, etc., based on American and British methods are given. EF (8d)

Electrolytic Deposition of Copper-Nickel-Iron Alloys (Elektrolytische Abscheidung von Kupfer-Nickel-Eisen Legierungen). H. Paweck, J. Bauer & J. Dienbauer. *Zeitschrift für Elektrochemie,* Vol. 40, Dec. 1934, pages 857-862. Deposits of Monel metal and other variable alloys were made by using a simple sulphate electrolyte with additions of Na-citrate and regulating the current density. WB (8d)

Platinum Black (Über Platinschwarz). G. von Hevesy & T. Somiya. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 171, Nov. 1934, pages 41-48. X-ray investigation on Pt-black prepared by electrolysis of a solution containing 0.1% Pb-acetate showed that only 0.2-0.3% Pb was in solid solution whereas over 7% Pb was found in the electro-deposited Pt. A 16-hour vacuum anneal at 605°, 640° and 720° C. eliminated 2%, 53% and 85% respectively of the total Pb content. The quantity of Pb in Pt black was studied in relation to the Pb content of the electrolyte. Experiments on electro-depositing Pt from Pt-chloride solutions containing Tl, Cd or Zn instead of Pb were made. Only Tl was found to have the same qualitative effect as Pb. A black Pt deposit was obtained only when the Cd-chloride did not exceed 0.02% and the presence of Zn-chloride always resulted in a gray deposit. Investigation of the particle size of Pt black by measuring half-value widths of X-ray interferences showed that the best kind of Pt black involves the largest particle size. EF (8d)

Automobile Bumpers are Polished, Plated and Buffed Rapidly. John M. Bonbright. *Steel,* Vol. 95, Sept. 3, 1934, pages 23-25. See "Applying Finish to Chevrolet Bumpers," *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 19. MS (8d)

Electrolytic Zinc Plates. C. C. Downie. *Electrical Review,* Vol. 115, Aug. 3, 1934, page 150. Zn plates for photo-engraving can be made by electrodeposition in much the same manner as Cu sheets. Electrolyte usually contains 8% $ZnSO_4$ with H_2SO_4. The voltage required depends upon the acidity. Cathode plates are oscillated to cause the Zn to be deposited uniformly as a flat surface. Electrolyte is agitated continuously and is repeatedly filtered to remove suspended impurities. Thickness of deposit and surface characteristics are controlled by acidity and rate of circulation of the electrolyte and by the current density. This makes possible in one operation the production of a finished product, hitherto made by rolling out the plates, heat treating them, and then sand-blasting or treating them chemically to obtain the desired surface. MS (8d)

Progress of Metal Coating Technique as Reflected in the German Patent Literature (Fortschritte der Metallüberzugstechnik an Hand der deutschen Patent-literatur). K. Nischk. *Oberflächentechnik,* Vol. 11, Nov. 6, 1934, pages 237-240. Interesting 1933 patents covering electroplating or coating metals in other ways for protection from corrosion or for other purposes are reviewed. Of special interest is DRP 576585 covering the simultaneous deposition of metals (alloys). These are obtained by applying different voltage and current density for each metal in a pulsating manner so that when the current flows for the deposition of one particular metal no other current flows. A common anode or separate anodes for each of the several metals to be deposited may be used. Au-Cu-Ni and Ag-Cu-Ni deposits of great hardness have been produced in this manner. The color of the deposit can be changed readily by varying the Ni content from 2 to 50 parts in 1000 parts of the total deposit. Methods for increasing locally the thickness of an electrodeposit as desired are described in DRP 576099 and 582633. DRP 572342 deals with a method to protect silverplated ware from tarnishing by immersion in solutions of persulphates, chromic acid or copper-ammonium-chloride. Ha (8d)

How Attractive Finish Helps Metal Products Sales. 21. Cadmium Plating. W. L. Cassell & A. B. Hoefer. *Iron Age,* Vol. 134, July 12, 1934, pages 24-29. The chief features of Cd plating, first used commercially in 1919, and some of the principal applications are given. Cd applied as a thin layer on almost any basis metal forms a non-porous coating completely covering the surface and protecting it against corrosion. Cd is applied by electroplating in the same manner as Cu, Ni and Cr. Chief distinction of Cd plating lies in the fact that (1) well compounded Cd baths are easily controlled, (2) plating is accomplished at room temperature, (3) no toxic or obnoxious fumes are evolved, and (4) Cd bath has good throwing power, i.e., ability to deposit metal into deep recesses. One disadvantage is that because of the softness of Cd it may be removed in buffing and polishing if the usual conditions of speed and pressure obtain. VSP (8d)

Electroplating in China. Walter Buchler. *Platers' Guide,* Vol. 30, Dec. 1934, pages 22-23. WHB (8d)

Packard's Set-Up for Chromium Plating. *American Machinist,* Vol. 78, Dec. 1934, pages 840-844. Continuous automatic equipment and the stationary tank equipment are described for Cu-, Ni- and Cr-plating. Ha (8d)

Significance of Anode and Cathode Efficiencies. C. B. Young. *Steel,* Vol. 95, Nov. 19, 1934, pages 38, 51. Although it is impossible to obtain 100% anode and cathode efficiencies in electroplating baths, they are kept as high as possible. It is preferable to have them equal. If anode efficiency exceeds cathode efficiency, metal ion concentration, pH, and density of solution, all increase. If cathode efficiency exceeds anode efficiency, opposite effects will result. MS (8d)

8e. Metallic Coatings other than Electroplating

Prevention of Corrosion and Durability of Hot Galvanizing Equipment (Ueber die Vermeidung von Anfressungen und Haltbarkeit der Zinkpfannen bei Feuerverzinkungsanlagen). Heinrich Meyer auf der Heyde. *Kalt-Walz-Welt,* Oct. 1934, pages 77-78. The durability of hot galvanizing kettles can be greatly increased by proper walling in of the vessel. Vessels treated according to the method described stood up for 3½ years. The importance of proper heating conditions is also emphasized. GN (8e)

Coated Sheets and their Mechanical Working (Plattierte Bleche und ihre Verarbeitung). K. Halfmann. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Dec. 8, 1934, pages 1421-1422. For reasons of economy, ordinary steel sheets are coated with metals or alloys to produce the required properties. This can be done by (1) welding and hot-rolling, (2) electroplating, (3) spraying processes, (4) immersion or recasting processes. Advantages and fields of application of each method are discussed. Behavior under deep-drawing, welding and finishing processes is described. Applications are reviewed. Ha (8e)

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How Attractive Finish Helps Metal Products Sales. 22. Coating with Sprayed Metal. Arthur B. Tickle, Jr. *Iron Age,* Vol. 134, July 19, 1934, pages 14-17. Description of metal spraying process in which a metal wire is fed into an oxygen flame, and melted. The molten metal is broken up into a finely divided condition by a jet of compressed air, which also carries and deposits the particles on a prepared metal surface. An important factor in spraying which requires close attention is the distance from the pistol to the work. Other variables are: (1) speed of work in r.p.m., (2) feed or travel of pistols, (3) air pressure, and (4) temperature. Metal spraying is one of the most practicable and economical methods of producing a coating of Al on steel. Other applications and advantages of the process are considered. VSP (8e)

New Method of Galvanizing Affords Uniform Coating. J. L. Schueler. *Steel,* Vol. 95, Aug. 27, 1934, pages 40-41. As the annealed and cleaned wire emerges from the Zn coating bath it passes through a mechanism for regulating the amount of Zn remaining on the surface. It then is subjected to the action of a controlled flame which smooths and evenly distributes the coating, thereby sealing pinholes or voids. MS (8e)

Preparation of Certain Intermetallic Compounds (Sur la Préparation de Certains Alliages Définis). Pierre Pingault. *Comptes Rendus,* Vol. 199, Nov. 26, 1934, pages 1223-1225. In studying the formation of $FeSn_2$ formed in tinning baths, the author observed that the $ZnCl_2$ used for cleaning reacts on the Fe in the presence of H_2O to give Zn oxychloride and $FeCl_2$ while the bath is maintained at about 250° C. It is this $FeCl_2$ that reacts with Sn to give $FeSn_2$. FHC (8e)

Metal Spraying Process in Electrical Manufacturing. John A. Campbell. *Electrical Manufacturing,* Vol. 13, Nov. 1934, pages 26-28, 40. The carbon industry has for several years been spraying Cu on carbon resistors to obtain an intimate contact for connections to metallic conductors. Carbon brushes are treated in same way to facilitate the soldering of pigtails to the brush. Radio tube manufacturers make shielded tubes by spraying Zn directly on the glass. Terminal contacts on Globar resistors are obtained by metal spray, brass for low temperature to permit soldering and, for higher temperatures, Monel, Ni or Cr steel is sprayed on ends. Condensers formerly made with Sn foil are now made with Al foil with the ends sprayed with Cu so wire can be soldered on for connection. WB (8e)

Securing Corrosion Resistance at Low Cost with Clad Sheets. Allen F. Clark. *Machine Design,* Vol. 6, Dec. 1934, pages 22-24. Recent uses in machinery of stainless-clad and Ni-clad steel are discussed with cases where use of this type of material is prohibitive. Tensile-test results on various sizes of Ni-clad steel sheet are given. Composite steel sheet (stainless clad type) can be sheared, bent, flanged, formed, welded and riveted without cracking or peeling of the layers. The essential difference in working ordinary steel and duplex plate is the need for heating to prevent possible injury to the veneer. In shearing, punching, drilling and tapping operations the veneer should be cut first. Riveting is not considered as efficient or economical as welding. The latter is done either with 2 different electrodes, one for each side, or with an alloy electrode used for both sides. WH (8e)

9. TESTING

9a. Inspection & Defects, including X-Ray Inspection

C. S. BARRETT, SECTION EDITOR

Detection of Internal Strain by Radiograph. Shinsuke Tanaka & Chujiro Matano. *Proceedings Physico-Mathematical Society of Japan*, Vol. 16, Aug. 1934, pages 288-290. Plastic deformation due to bending, torsion, compression is studied radiographically in bodies of Al containing fine wires of Nichrome or W and in paraffin specimens incorporating fine Cu wires. In all cases X-ray photographs presented were taken at an angle of 0°, 45° and 90°. WH (9a)

A Simple Means to Distinguish Different Aluminum Qualities (Ein einfaches Mittel zur Unterscheidung der verschiedenen Aluminiumqualitäten). A. von Zeerleder. *Aluminium*, Vol. 17, Oct. 1934, pages 88-90. To distinguish between pure Al, Cu free Al alloys and Cu containing Al alloys, 2 methods are used. One employs a scratch needle of Al wire having a Brinell hardness of 70-80 kg./mm.^{2}; since pure Al is in any state softer than its alloys it will be scratched by the needle while the latter will not make any impression on the alloys. To test for presence of Cu a few drops of a 20% NaOH solution are put on the bright surface for 10 min. Cu containing alloys will show a blackening of the spot while Cu free alloys remain white or become weakly grey or brown. These methods are recommended for quick routine determination. Ha (9a)

Founding Properties of Alloys. A. Portevin. *Metal Progress*, Vol. 27, Jan. 1935, pages 47-48. Discusses various test pieces used for investigation and control of founding properties such as castability, pipe and blisters, and aptitude to cracks and internal stresses. WLC (9a)

Instances of Cracking in the Amalgamation Test of Brass Shells Previously Normalized and then Loaded (Nota intorno ad alcuni fenomeni di crepatura nella soluzione amalgamatrice di bossoli di ottone normalizzate e muniti di proiettili). L. Matteoli. *La Metallurgia Italiana*, Vol. 26, Nov. 1934, pages 861-868. In order that a brass object may give a satisfactory amalgamation test, it must be free of all stresses, for any stress (induced by flexing, torsion, tension, etc.) will cause even normalized brass to crack during the amalgamation test. Thus brass shells, loaded by forcing the ball into position, have cracked in the amalgam solution. However, if the heat treatment is applied after inserting the projectile in the shell, much better tests are obtained. AWC (9a)

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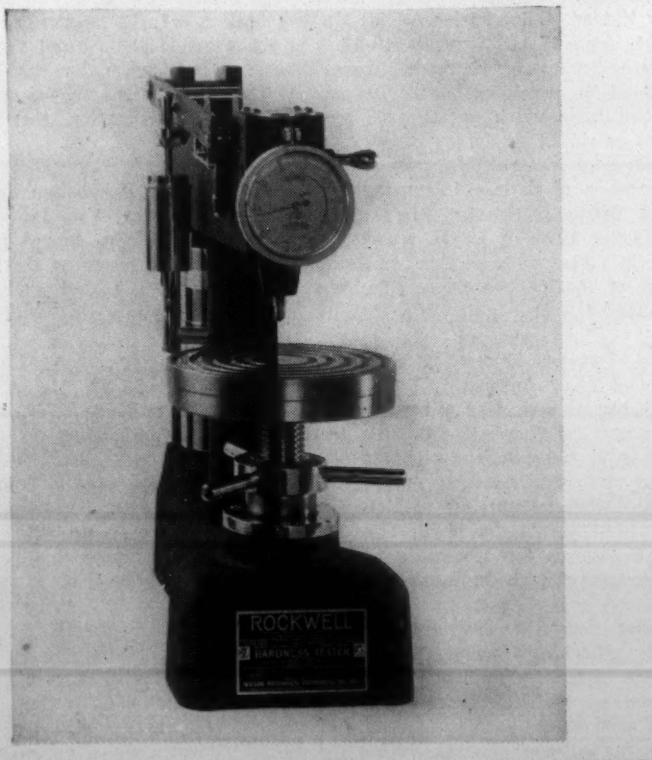

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Locomotive Tires. A Discussion of the Causes of Typical Tire Failures. Leland Grant. *Metals & Alloys*, Vol. 5, Nov. 1934, pages 231-235; Dec. 1934, pages 277-280. Four types of failure in tires are described and it is suggested that methods of making tires are not adapted to development of best properties of the metal for this service. Three methods used in tire manufacture are (1) from individual ingots flattened, punched, hammered partly to shape and finished on tire mill; (2) similar work on slices cut from larger ingots except that the hammering is omitted and hot work completed in one heat; and (3) suitable size billet is flattened, center punched out and tire rough rolled, reheated and finished rolled. It is reported that tires show coarser dendrites than other forgings having been similarly reduced from ingot. WLC (9a)

Welded Heat Exchanger Shells Inspected Rapidly by X-Ray. N. L. Mochel & H. H. Bates. *Iron Age*, Vol. 133, June 28, 1934, pages 10-15. Describes the facilities of the new X-ray laboratory of the Westinghouse Electric and Manufacturing Co. at South Philadelphia for inspecting welded heat exchanger shells, castings and miscellaneous parts. Some of the features dealt with are: a battery driven work holding truck, push button controls, adjustments of work and tube and the indicating devices; also the X-ray machine and control room, which is convertible into a dark room. Method for X-raying very small specimens is outlined. VSP (9a)

Two Variations of the Powder Method of X-Ray Analysis of Crystals. J. P. Blewett. *Journal of Scientific Instruments*, Vol. 11, May 1934, pages 148-150. The Hull-Debye-Scherrer method of crystal analysis necessitates relatively long exposure to obtain satisfactory photographs; greater intensity can be obtained with the Seeman-Bohlen camera but diffraction angles less than 20 degrees are practically unobtainable. Two methods are described which make for greater intensity and attainment of diffraction angles at almost zero degrees. In one method a converging beam of X-rays, focussed on the circumference of a circular camera, is scattered by a powder specimen mounted on the circumference of the camera opposite the point at which the X-rays are focussed. The other method employs a somewhat different focussing principle applied to a wide beam of X-rays. RAW (9a)

Industrial Electronic Control Applications. F. H. Gulliksen & R. N. Stoddard. *Electrical Engineering*, Vol. 54, Jan. 1935, pages 40-49. Photoelectric control applications for industrial manufacturing processes, inspection and timing devices for welding are described. Ha (9a)

9b. Physical & Mechanical Testing

W. A. TUCKER, SECTION EDITOR

Thermo-Elasticity. E. G. Coker. *Engineering*, Vol. 138, Oct. 12, 1934, pages 373-374. Reviews progress made in measuring temperature change taking place during stress. In former experiments the thermopiles used were so slow in action that loading had to be carried out slowly. During this time conduction and radiation were going on so that the readings obtained did not give a true measure of the stress in the bar. With the new apparatus a true maximum reading can be obtained in 3 or 4 sec. It is possible to follow the changes in temperature in a bar under an oscillating load of moderate frequency. The apparatus is of the type used in physiological researches on nerves and muscles. Photographs of the apparatus are given and graphs show results of actual experiments. LFM (9b)

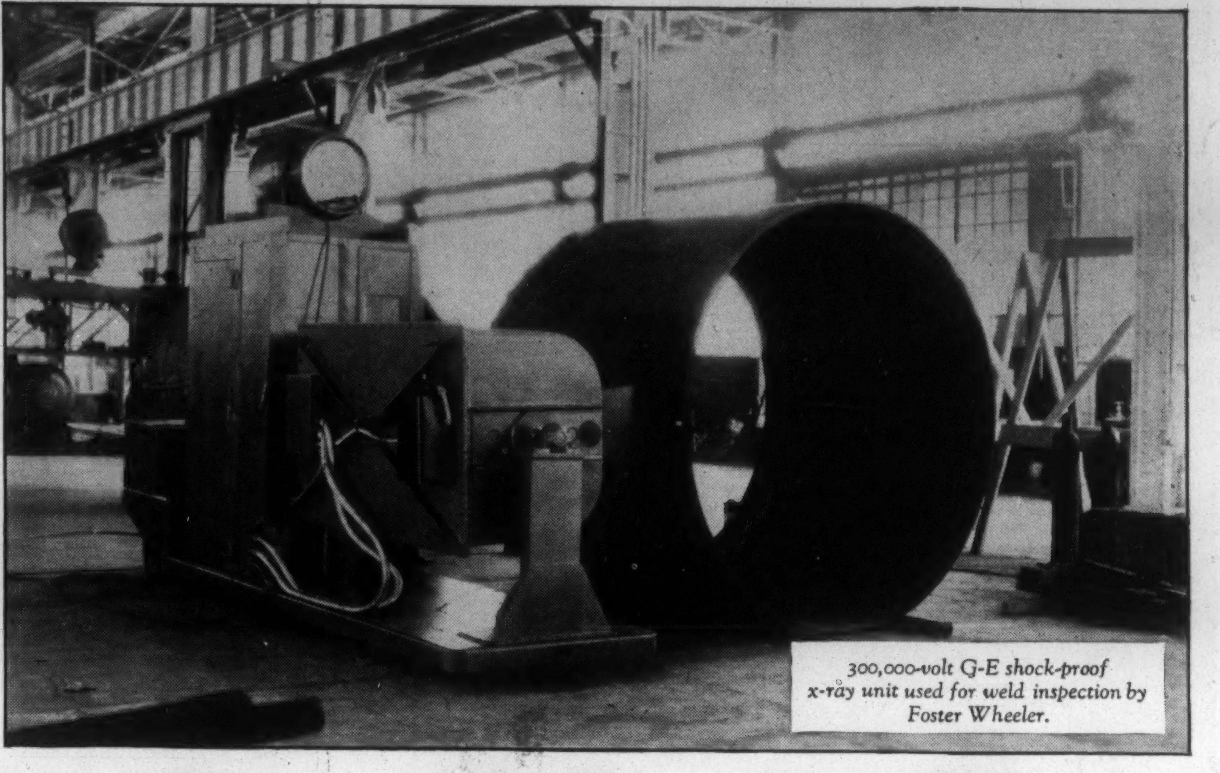
Test Bars From the Foundryman's Point of View. S. Southcott. *Foundry Trade Journal*, Vol. 51, Aug. 2, 1934, pages 73-75. From a paper read before the Wales and Monmouth branch of Institute of British Foundrymen. Tensile, compression, shear, impact, repeated impact, Brinell, transverse, fluidity and shrinkage tests are discussed. In author's opinion the most reliable of all tests for general foundry practice is the transverse test which includes bending strength and deflection. The method usually adopted by the author is to cast 3 test-bars in a flask on a slope of about 6 inches. It is interesting to note that the higher breaking strength was obtained by the author when the transverse test was carried out, with the bar the top side of which was in tension. AIK (9b)

The Notch-Impact Test (De Kerfslagproef). P. Schoenmaker. *De Ingenieur*, Vol. 49, Dec. 14, 1934, pages W.162-W.168. The nature of the notch-impact test is explained and the factors which influence the result, as shape of specimen, velocity of impact, shape of notch, etc., are discussed. Th preparation of specimens, the various standards and test methods developed and in use in the principal countries are described and compared. Ha (9b)

Design of Large Bending Roll Yoke Predetermined Photoelastically. *Steel*, Vol. 95, Aug. 20, 1934, page 39. Baldwin-Southwark Co. was to make 11,000 lb. electric steel casting to resist direct load up to 1,650,000 lb. normally and to more than twice this occasionally, while being subjected to a much smaller side load. Photoelastic study of a celluloid model showed no dangerous concentration in the proposed design. MS (9b)

Physical Testing of Gray Cast Iron (Quelques Réflexions sur les Essais Mécaniques de la Fonte Grise). Navarro Alcacer. *Bulletin de l'Association Technique de Fonderie*, Vol. 8, Nov. 1934, pages 515-531. Paper presented at meeting of Association Technique de Fonderie, Mar. 14, 1934. The relation of various physical properties of cast iron. By the use of the ratio of two work of rupture measurements from different tests, the various strength figures for the material may be calculated from formulae given. The ratios of surface to volume and the work of rupture in transverse test to that in compression test are very important values. 15 references. WHS (9b)

G-E X-RAY OKAYS WELDS at Foster Wheeler Plant



300,000-volt G-E shock-proof x-ray unit used for weld inspection by Foster Wheeler.

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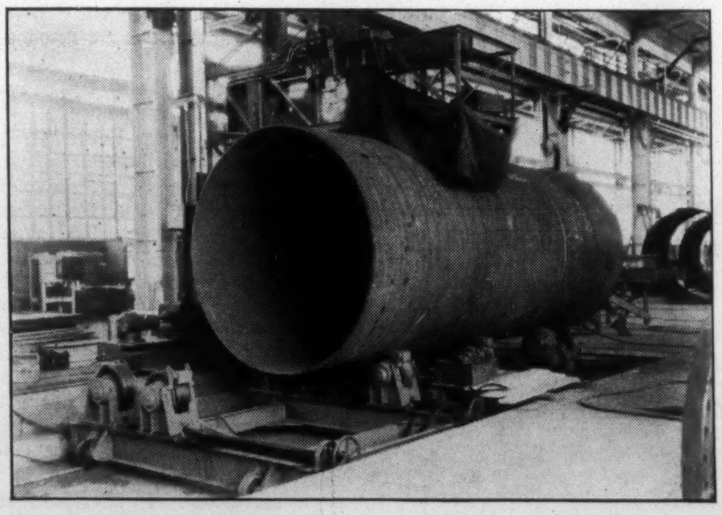

Foster Wheeler installation of G-E automatic a-c arc welding machine.

The first 225 tons of Class I vessels produced contained 1400 linear ft. of automatically welded seams, x-ray examination of which revealed only 0.04% defects, which were totally eliminated before completion of the vessels. With better edge preparation the company expects to avoid even this small percentage of weld defects.

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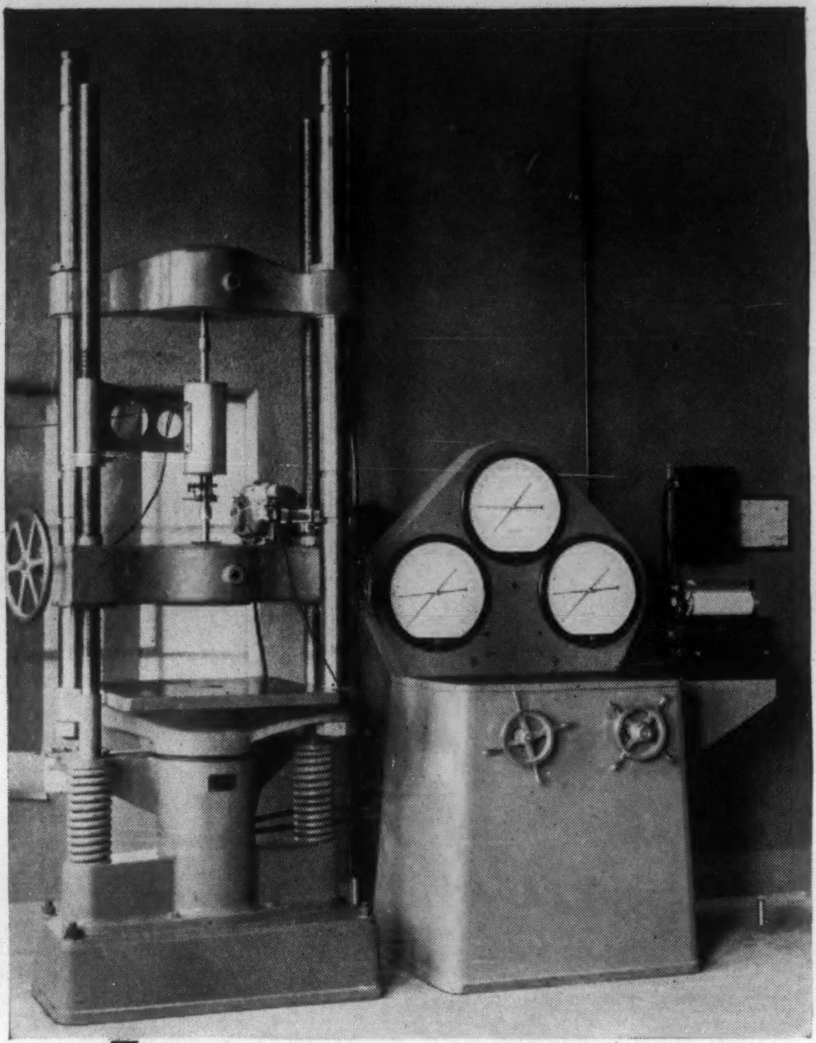

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The Practice of Partial Radiation Pyrometry (Die Praxis der Teilstrahlungspyrometrie). G. NAESER. *Stahl und Eisen,* Vol. 54, Nov. 8, 1934, pages 1158-1160. An optical pyrometer is described in which the temperature of a bare molten metal is corrected for black body conditions by means of color filters so that a very close approximation to the true temperature is obtained. SE (9b)

Determining Inherent Stresses in Large Castings and Forgings. RENE W. P. LEONHARDT. *Machinery,* London, Vol. 44, Sept. 13, 1934, pages 705-707. Tests and equipment, large micrometer calipers for measurement of expansion to determine high stresses. WB (9b)

New Method for the Determination of Young's Modulus (Méthode Nouvelle pour la Détermination du Module d'Young—Application Spéciale de cette Méthode au Classement de Qualité des Fontes-Élasticimètre Pendulaire). P. LE ROLLAND & P. SORIN. *Bulletin de l'Association Technique de Fonderie,* Vol. 8, Sept. 1934, pages 425-429. Paper presented at the Nancy Foundry Congress, July 1934. Balanced pendulums principle, in which the energy from one pendulum is transferred to the other through the test specimen. Th length of time between 2 successive stops of either pendulum is taken as a measure of Young's Modulus. WHS (9b)

The Lower Yield Point in Mild Steel. B. P. HAIGH. *Engineer,* Vol. 158, Oct. 5, 1934, pages 330-331. From paper read before the British Association for the Advancement of Science, Sept. 12, 1934. Includes discussion. LFM (9b)

Researches in Impact Testing. H. HALLAM & R. V. SOUTHWELL. *Engineer,* Vol. 158, Oct. 5, 1934, pages 331-332. From paper read before the British Association for the Advancement of Science, Sept. 12, 1934. LFM (9b)

New Micro Volume Meter (Über ein neues Mikrovolumenometer). H. HAUPTMANN & G. E. R. SCHULZE. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 171, Nov. 1934, pages 36-40. Describes new volume meter which measures densities of 0.01 cc. material with 1% accuracy. Density determination on Cu (wire) and SiO_2 yielded 8.83 and 2.672 respectively. EF (9b)

Shape of Impact Test Piece. F. GIOLITTI. *Metal Progress,* Vol. 27, Jan. 1935, pages 45-46. Results of studies by Italian State Railways indicate that technical details of size and shape of impact test pieces should be carefully studied before standardization. WLC (9b)

Determination of Surface Smoothness of Workpieces and Their Susceptibility to Smoothing (Bestimmung der Oberflächenglätte von Werkstücken und deren Glättbarkeit). E. FRANKE. *Oberflächentechnik,* Vol. 11, Nov. 20, 1934, pages 249-251. A new method to determine smoothness is described in which the pull is measured which moves a piece of definite weight over the surface; the gliding piece is of highly polished glass. Instead of pulling the glide piece, the angle may be determined under which the workpiece can be tilted before the gliding piece begins to slide down. The angle is a measure of smoothness. A few measurements with alloy steels are described. Ha (9b)

Breaking Tests Under Planar Plastic Deformation (Zerreissversuche bei ebener plastischer Verformung). GERHARD BARANSKI. *Zeitschrift für Metallkunde,* Vol. 26, Aug. 1934, pages 173-180. A mathematical treatment of the stresses and strains involved in the deformation of a solid under uniaxial and planar loading, up to the maximum tensile load, is given. For the analysis of the stresses and strains occurring after the maximum load, when the reduction in area becomes important, a graphical method is derived from the earlier works of H. Hencky and L. Prandtl *(Zeitschrift für angewandte Mathematik und Mechanik,* Vol. 3, 1923, pages 241, 401). The application of these analyses to test specimens is demonstrated for the cases of brass (63% Cu) and Mn-Si steel. The stress-strain (component in the direction of the stress) curves for brass, in the neighborhood of the maximum stress, were found to be similar whether uniaxial or planar loading was used and conformed to von Mises' hypothesis. In the case of Mn-Si steel there was a like behavior, except that the first plastic deformation obeys Mohr's hypothesis of maximum shear stress. The apparatus used is described in detail, as is also the development of a special rectangular test specimen reinforced at the edges in such a manner as to ensure deformation in only two dimensions. 16 references, 14 diagrams. FNR (9b)

Elongation of Metals at Tensile Test Fracture. A. K. CAMERON. *Commonwealth Engineer,* Vol. 22, Aug. 1, 1934, pages 13-17; Sept. 1, 1934, page 59. Discusses the effect of gage length and sectional area of a metal test piece upon the elongation in tension tests. The relationships put forward by various investigators are examined critically. The nature of action taking place when a metal is stressed beyond the elastic limit is analyzed and a formula for elongations which gives results in conformity with the known phenomena is deduced. In the light of this formula the various standard specifications (American, British and Australian) for structural steel are criticized. Conclusions: "If on a diagram of E (% elongation) against $A^{0.3}L^{-0.6}$ (A = sectional area of specimen, L = gage length) two lines be drawn, one to represent the mean line for the type of steel being considered, and the other to represent the minimum permissible requirement and this to be used in conjunction with a diagram of values of $A^{0.3}L^{-0.6}$ for different values of A and L, an easy method is available for readily comparing one test result with another or with some standard set of conditions and determining at once where an unusual area of gage length has been used whether the result is satisfactory or otherwise." The main objection to the practical application of the formula is the difficulty of computing the values of $A^{0.3}L^{-0.6}$ which are best plotted against L. If such a diagram is not available, isolated results may be compared by computing $A^{0.3}$ and $L^{-0.6}$ on a slide rule equipped with log-log scales. WH (9b)

Determination of the Modulus of Elasticity of the Common Metals under Different Physical Conditions (Berechnung der Elastischen Moduln für die Verschiedenen Texturen der Regulären Metalle). D. A. G. BRUGGEMAN. *Zeitschrift für Physik,* Vol. 92, Dec. 7, 1934, pages 561-587. Theories previously developed for determining the modulus of elasticity for single crystals are enlarged to include polycrystalline metals in the drawn, forged and heat treated state. Metals studied were Cu, Al, Ag, Au, Fe and W. For cold worked, Cu, Al, Ag, Au and Fe, especially where deformation occurs in small steps, small variations in the E and G values are observed. FHC (9b)

9c. Fatigue Testing

H. F. MOORE, SECTION EDITOR

The abstracts appearing under this heading are prepared in cöoperation with the A.S.T.M. Research Committee on Fatigue of Metals.

Determination of the Endurance Limit of Wires. Development of a Suitable Testing Machine (Bestimmung der Begewechselfestigkeit von Drähten. Bau einer entsprechenden Materialprüfmaschine). W. FRIEDMANN. *Mitteilungen des Wöhlerinstituts,* No. 22, 1934, 93 pages. Since the usual fatigue-testing methods are not readily applicable to small-diameter wire an attempt was made to adapt the Föppl-Heydekampf repeated bending machine for this purpose. Since no reduced section can satisfactorily be used on small wire specimens, cold working of the gripped ends of the wire to strengthen them and confine the fracture to the desired test section was resorted to. After many trials it was possible by means of special roll devices, somewhat similar to those used in other similar problems at the Wöhler Institute, to apply sufficient cold working for this end on soft wires, but wire already hard-drawn could not be satisfactorily dealt with. Insertion of paper or paper plus lead foil between specimen and grips had to be used in many cases, and even this did not wholly avoid breakage in the grips. The specimen (wire of 2 to 3 mm. diameter) and a steel plate spring are both gripped side by side and both deflected at the same time. Modifications in the Föppl-Heydekampf machine and in its control devices, and the methods of calibration are described, the machine was operated at 1500 to 3000 cycles per minute. The up-step method of testing usually employed at the Wöhler Institute (but not elsewhere generally considered reliable because of strengthening by understressing) was employed, the total number of cycles on which the so-called endurance limit was based in the tests of copper, aluminum and their alloys, was only two million, although it is generally recognized that many times that number of cycles are required to give reliable endurance limits on these non-ferrous materials. The metallurgy of the materials used is badly mixed, either through misprints or otherwise. One material, termed "bronze" is said to contain 99.99% Cu. Another called "aluminum" is described as "90.5% pure, less than 0.2% Si." Despite all precautions all specimens of this material, hard-drawn, broke in the grips. The "endurance limits" alleged to be determined by the tests show wide scatter in most cases. A cadmium bronze of 99.82% Cu, 0.16% Cd drawn to 94,000 lbs./in.^{2} tensile strength gave from 23,500 to 29,000 lbs./in.^{2} Annealed copper gave 17,500-18,500, hard drawn copper 18,500. Hard drawn 99.5% Al gave 8,500-13,000. Aldrey (0.20% Fe, 0.55% Si, 0.43% Mg, balance Al) in two different diameters of wire with similar tensile strengths, gave an endurance ratio of 0.22 to 0.29 in one size, 0.34 to 0.40 in another. Despite the detailed description of each test of each specimen it is difficult to determine if the scatter so prevalent in the whole series of tests was due to faulty material or whether the test method or apparatus was at fault. The account is interesting as representing a great deal of work but the reported endurance limits do not appear necessarily reliable, nor is it proven that the suggested modification of the Föppl-Heydekampf machine makes it suitable for general use on wire. HWG (9c)

Testing of Structural Fundaments Submitted to Alternating Loads by Means of the "Pulsating Testing Machine" (Vereeniging voor Laschtechniek. Beproevingen van constructie-onderdeelen, die aan wisselende belastingen onderworpen zijn, met behulp van de Pulsatormachine.) M. G. DRIESSEN. *Polytechnisch Weekblad,* Vol. 28, June 21, 1934, pages 385-387. Describes the testing machine devised by the Dutch State Railroads for endurance tests and tabulates testing results on riveted and welded joints. WH (9c)

Overcoming Fatigue of Shafts of Press-Fitted Units. R. E. PETERSON & A. M. WAHL. *Machine Design,* Vol. 6, Dec. 1934, pages 25-27, 68. The decrease in endurance strength of an ordinary heavy press fit is due to a localized system acting in a material weakened by rubbing corrosion. Regarding the fracture, press fit specimens show irregular rupture areas. Cracks originated at a number of places on the periphery. Failure generally started on the shaft surface inside the press fit varying from 0.02-0.25 in. from the edge of the collar. Photo-elastic and fringe method were used to determine the principal stress differences. An ordinary press fit member was found to decrease the endurance strength of a shaft to roughly half the endurance limit of the shaft material. Using a grooved construction and rolling the shaft surface were found to be very effective in increasing the endurance strength of shafts with press fitted members. Grooves reduced the stress peaks at the corners. WH (9c)

Torsion-free Cable for High Tension Overhead Lines (Das drehungsfreie Seil für Hochspannungs-Freileitungen). J. GRÖBL & F. WAGNER. *Elektrizitätswirtschaft,* Vol. 15, June 15, 1934, pages 219-222. Torques have been recently discovered in overhead transmission lines of the customary design. These twisting moments are eliminated by new cable constructions which were found to possess higher endurance strength resulting in longer service times. Besides larger dynamic stresses withstood, the static load is also affected. With increasing margin between greatest cable tensile strength and fatigue strength, service times are extended. A critical comparison between the customary cable materials shows that, with reference to equal cable cross sections and the widely applied maximum tensile cable stresses of 1600 kg./cm.^{2} and 800 kg./cm.^{2} for Cu and Al respectively, Cu is twice as much endangered by vibrations as Al. Based on cross sectional areas of equivalent electrical conductivities, Cu cables, however, are five times superior to Al ones of identical electric properties. Conclusions are drawn in regard to the most convenient dimensioning of Cu and Al cables with the object of insuring maximum safety against fatigue failures. The fatigue strength of cables, according to the original paper, is fixed by the dynamic stresses + static tensile stress. The larger the margin between the maximum static tensile stress and the endurance strength the longer the life. Now, this has been done: after 10 years of service the number of fractures per 100 suspension clamps has been plotted against the maximum static tensile stress to which the cables were submitted. The diagram shows to advantage the reduction of the max. tensile stress and the utilization of torsion-free cables. WH (9c)

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Design and Construction of Overhead Transmission Lines (Planung und Bau von Freileitungen). GRÖBL. *Elektrizitätswirtschaft,* Vol. 24, Nov. 25, 1934, pages 491-496. Paper before the Reichsverband der Elektrizitäts-Versorung, Oct. 1934, summarizes a several years' experience of one of the largest German power companies on its transmission lines. A statistical evaluation of broken wires proved that larger diameter cables are more susceptible to fatigue failures than smaller cables which fact indicates a handicap for Al lines of the same electric conductivity as Cu. Based on the inspection results, an empirical formula is advanced expressing the danger ratio for 2 differently sized cables of the same material. The former endurance strength equation of Schwinning could not be confirmed and a new equation is introduced. The number of stress reversals withstood in relation to endurance stress is graphically shown for Al, Aldrey and Cu. The effect of local conditions, i.e., the effect of direction, velocity and frequency of occurring winds upon fatigue failures, and fatigue failures in relationship to service times are dealt with statistically. WH (9c)

Endurance Strength of Welded Joints (Dauerfestigkeit von Schweissverbindungen). OTTO GRAF. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Dec. 8, 1934, pages 1423-1427. The influence of external and internal condition of welded seams and the shape of the seam itself on the endurance strength of welds is reviewed on the basis of the work done in this direction so far; in general, in order to obtain high endurance strength under repeated alternations of load only gradual changes of section in and near the weld are permissible. Heating and cooling during welding produce internal (residual) stresses in and near the joint which may reach values locally which come close to the flow limit of the material. The distribution of these residual stresses depends largely on the welding process, they can produce warping and premature cracks. Annealing and selection of suitable materials will prevent such failures. The admissible stresses depend on the nature of the load (static, dynamic, tension, bending, etc.) and on the shape of the joint. Butt-welds oblique to the axis and subsequent machining give joints which can be equivalent to the solid material if the joint is made under strict observation of all precautions. Ha (9c)

Electrical Operation in Fatigue Testing. R. BAUDER & H. MACKH. *Electrical Review,* Vol. 115, Oct. 12, 1934, page 475. See "Electric Drive of Fatigue Bending Machines," *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 25. MS (9c)

An Explanation of the Development of Cracks by Fatigue Stresses in the Spokes of Railway Carriage Wheels. GEORGE WALTER CANDSDELL HIRST. *Journal & Transactions Institution of Engineers of Australia,* Vol. 6, Aug. 1934, pages 272-275. The author accounts for the stresses which must occur to produce cracked spokes by fatigue failure and demonstrates that the repeatedly applied load which must be acting is by calculation in good agreement with the measured load. The fractures of the wheels' spokes were evidence of fatigue stresses and a stress analysis of a new wheel design is made whereby the effect of shrinkage of the full tire is to cause a very small permanent deformation of the spokes. The repetitive load would have to attain 50,000 lbs./in.^{2} before reaching the endurance limit of the cast steel spokes, whereas the measurements showed that the repetitive load does not exceed 40,000 lbs./in.^{2}. WH (9c)

Corrosion-Bending Vibration Strength of Steel and Its Increase by Additions to the Corroding Solution (Korrosionsbiegewechselfestigkeit von Stahl und ihre Steigerung durch Zusätze zur Korrosionslösung). ALFRED JUENGER. *Mitteilungen aus den Forschungsanstalten des Gutehoffnungshütte-Konzerns,* Vol. 3, July 1934, pages 55-84; Aug. 1934, pages 85-101. Literature dealing with corrosion bending strength (i.e. bending vibrating test whereby the place of greatest stress is simultaneously acted upon by a corroding liquid sprayed against it) is reviewed and new tests are described. Ha (9c)

9d. Magnetic Testing

L. REID, SECTION EDITOR

Variation in the Coefficient of Rigidity of Nickel as a Function of Magnetization (Variation du Coefficient de Rigidité du Nickel en Fonction de l'Aimantation). RAYMOND JOUAUST. *Comptes Rendus,* Vol. 199, Nov. 26, 1934, pages 1195-1196. The coefficient of rigidity of Ni decreases as the magnetizing field is increased from 15 to 70 oersteds. This is comparable to results obtained by Honda and Terada which showed a diminution of elasticity of Ni as a function of magnetization. FHC (9d)

10. METALLOGRAPHY

J. S. MARSH, SECTION EDITOR

Aluminum-silver Compounds. F. E. TISCHENKO. *Chemical Journal (Journal Obschei Chimii), Leningrad-Moscow, U. S. S. R.,* Vol. 3, (LXV), No. 5, 1933, pages 549-557. In Russian. Alloys were melted in laboratory graphite crucibles; heating and cooling curves were taken. The Al usually used was of 99.9% purity with about 0.1% Fe. From the results, 2 constitutional Al-Ag diagrams were drawn, one corresponding to his heating and another to his cooling curves. Conclusions are: Al and Ag form $AlAg_3$ at the peritectic temperature of 771° C. The transformation of this compound occurs at 606° C. [Abstractor's comment: This observation is in agreement with the results obtained by A. F. Westgren and A. J. Bradley in their X-ray analysis. (*Philosophical Magazine,* Series 7, Vol. 6, 1928, pages 280-288)]. The β (high-temperature) modification of $AlAg_3$ forms a solid solution with Al the limit being 10.2% Al at 722° C. and decreasing with temperature. Al does not dissolve in $\beta_1 AlAg_3$. At 722° C. a eutectic is formed according to the heating curve. This eutectic consists of Al_2Ag_3 and solid solution of β and 10.2% Al. From the liquid alloy, Al_2Ag_3 is precipitated and remains stable from 752° to 711° C. Below 711° C. it is metastable. Th Al_2Ag_3 compound observed by Broniewski is considered by the author to be metastable crystals formed at ordinary rate of cooling. The stable form below 711° C. is the solid solution γ_{11} which is the solid solution of Al and $AlAg_2$. The saturation concentration of Al in this solution is 14.33% Al. The complete transformation of the metastable form of Al_2Ag_3 into solid solution γ_{11} may occur at long time annealing only. $AlAg_2$ dissolves about 3.2% Al and 1.3% Ag. At temperatures from 711° to 400° C., at about 1.3% Ag, simultaneous presence of γ_1 and β crystals is observed. Below 400° C. $AlAg_3$ and $AlAg_2$ crystals are present and a region of heterogeneity is observed between 7.7% and 11.1% Al. Westgren and Bradley determined by X-ray analysis the simultaneous presence of $\beta_1 AlAg_3$ and γ crystals between 7.7% and 8.5% Al. According to the author there is formation of a eutectoid at a concentration of 8.5% Al, which is disintegrated at about 400° C. [Abstractor's comment: The conclusions drawn by Tischenko regarding the compounds $AlAg_3$, $AlAg_2$ and Al_2Ag_3 and their relations do not agree with those made by Hoar and Rowntree. (*Journal Institute of Metals,* Vol. 45, 1931, pages 119-124.)] The paper is illustrated. AIK (10)

Structural Principles Involved in Carbides, Silicides, Nitrides and Phosphides of Electro-positive Metals (Die Bauprinzipien der Carbide, Silicide, Nitride und Phosphide elektropositiver Metalle). M. v. STACKELSBERG. *Zeitschrift für physikalische Chemie,* Abt. B, Vol. 27, Oct. 1934, pages 53-57. Summarizing his and his co-workers' extensive investigations, the problem of homöopolar lattice vs. salt-like ion lattice is answered in favor of the latter. There is a tendency in the structure of carbides of electro-positive metals for the anions to form a close-packed lattice in the tetrahedra (Be, Al, Si) or octahedra (Ti, Zr) interstices in which the cations are embedded. Prerequisite to the formation of this structural type is that the cations do not break up the anion lattice due to their number or size, as for instance in the case of ThC_2. SiC displays homoopolar character and TiC and ZrC exhibit metallic properties and thus form a link to carbides and nitrides of the transition elements (Fe group) investigated by Hägg (*Zeitschrift für physikalische Chemie,* Abt. B, Vol. 12, Feb. 1931, pages 33-56. See *Metals & Alloys,* Vol. 2, Nov. 1931, page 254). Insufficient information is available to uncover analogous laws holding for silicides, nitrides and phosphides. EF (10)

Constitution of the Alloys of Iron and Manganese. *Nature,* Vol, 133, Jan. 20, 1934, pages 111-112. Summary of paper read before Iron & Steel Institute in 1933 by DR. M. L. V. GAYLER. See "Alloys of Iron Research. Part XI." *Metals & Alloys,* Vol. 5, Mar. 1934, page MA 83. CSB (10)

On the Transition in the Copper-Gold Alloy. II. On the Migration of Atoms in the Lattice of Copper-Gold. W. S. GORSKY. *Physikalische Zeitschrift der Sowjetunion,* Vol. 6, 1934, No. 1/2, pages 69-76. In English. A Cu-Au alloy with 50 at. % Cu exists in the form of a disordered solid solution of face-centered cubic lattice (a = 3.87 A.U.) above 385°C. Below this temperature the alloy has a tetragonal (layer) lattice very similar to a face-centered cube. The equilibrium ratio a/c varies with quenching temperature. The present article reports X-ray measurements of the transition velocity of the lattice to the equilibrium state. A 50/50 Au-Cu alloy was annealed above 380°C. until equilibrium conditions were attained and then quenched and X-rayed. Samples were held for increasing lengths of time at 175°, 200°, 250°, 275°, and 300°C. and the change of lattice constants measured. The a/c-time curves do not take an exponential course. EF (10)

On the Transition in the Copper-Gold Alloy. III. On the Influence of Strain on the Equilibrium in the Ordered Lattice of Copper-Gold. W. S. GORSKY. *Physikalische Zeitschrift der Sowjetunion,* Vol. 6, No. 1/2, 1934, pages 77-81. In English. Mathematical derivation of the shifting of equilibrium (change of crystal dimensions or degree of disorder) in the Au-Cu lattice due to elastic strains induced by quenching and subsequent annealing at different temperatures. The final stress produced by slow deformation is almost twice the stress occurring during quick deformation and is ascribed to Young's modulus. EF (10)

Explanation of Properties of Materials on the Basis of Behavior of Monocrystals and Texture (Deutung der Eigenschaften technischer Werkstücke auf Grund von Einkristallverhalten und Textur). W. BOAS & E. SCHMID. *Berg- und Hüttenmännisches Jahrbuch,* Vol. 82, Sept. 28, 1934, pages 138-144. The behavior of metallic crystals with regard to anisotropic properties and the possibility of determining the behavior of polycrystalline materials on the basis of the monocrystal is investigated. The results of tensile tests made with monocrystals of Al, Cu, Ag, Au, α-Fe, W, Mg, Zn and Ca are given in a table, and the synthesis of plastic polycrystalline properties explained. Ha (10)

Crystallization of Metals from Sparse Assemblages. E. N. DA C. ANDRADE & J. G. MARTINDALE. *Nature,* Vol. 133, Sept. 1, 1934, page 321. Colloidal particles of gold and silver were grown by recrystallization of extremely thin sputtered films. Under the polarising microscope they appeared to be spherulites, (i.e. made up of crystalline fibers radiating from a center, each fiber behaving as an uniaxial crystal with its axis along a radius), even though normally the metals are optically isotropic. It is suggested that in the small fibers of these spherulites the crystalline structure is disturbed by the smallness of the transverse direction (the fibers are about 30 atoms across, 1000 atoms long). When the particles grow larger, the center becomes isotropic and only the edge remains double refracting. CSB (10)

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Electric Conductivity and Phase Diagram of Binary Alloys. Part 15. The System Lithium-lead (Elektrische leitfähigkeit und Zustandsdiagramm bei binären Legierungen. 15 Mitteilung. Das System Lithium-Blei). G. Grube & H. Klaiber. *Zeitschrift für Elektrochemie,* Vol. 40, Nov. 1934, pages 745-754. Thermal analysis and temperature-resistance curves for 48 different Li-Pb alloys were used to set up complete diagram. Compounds found were LiPb, M.P.482°C. and Li_7Pb_2, M.P.726°C., which melt without decomposing. Li_5Pb_2, Li_3Pb and Li_4Pb have their source in peritectic reactions. Upper existence limits are 642°C. for Li_5Pb_2, 658°C. for Li_3Pb, 648°C. for Li_4Pb. Solution of LiPb by Pb is slight, depends upon temperature and forms α solid solution. Two forms of LiPb exist, one stable above and one below 214°C. The temperature coefficient of electric resistance for LiPb, stable below 214°C. is negative, and positive for the other form. LiPb with excess Li forms β solid solution in surrounding areas, which below 214°C. go to β'; 53.3% Li is saturation limit for β solid solution. Li_7Pb_2 with excess Li forms γ solid solution with homogeneity range slightly more than 1%. Alloys around 80% Li showed strong undercooling, which was checked by heating curves. Test pieces for resistance measurements were homogenized for 30 days and slow cooled, were tested at 10°C. intervals (2°C. near the critical points) on temperature-resistance curves. The Li used was 99.0%; Kahlbaum's purest Pb was used. WB (10)

Electric Conductivity and Phase Diagram of Binary Alloys. Part 16. The System Lithium-tin (Elektrische leitfähigkeit und Zustandsdiagramm bei binären Legierungen. 16 Mitteilung. Das System Lithium-Zinn). G. Grube & E. Meyer. *Zeitschrift für Elektrochemie,* Vol. 40, Nov. 1934, pages 771-777. Thermal analysis and temperature-resistance curves for 58 different Li-Sn alloys were used to set up complete diagram. Compounds found were LiSn, M.P.485°C.; Li_7Sn_2, M.P.783°C.; Li_4Sn, M.P.765°C.; these melt without decomposing. $LiSn_2$ Li_2Sn, Li_5Sn_2 have their source in peritectic reactions. Upper existence limits are 326°C. for $LiSn_2$, 502°C. for Li_2Sn, 720°C. for Li_5Sn_2. Pure Sn does not take up Li to form a solid solution in any amounts ascertainable by test. LiSn with excess Li forms a solid solution in a concentration range of about 1%. Li_7Sn_2 with excess Sn forms α solid solution whose saturation limit at 720°C. is 76.0% Li. Above 10% Li the alloys are brittle and up to 40% Li are fine grained; above this, they are coarse grained. WB (10)

X-Ray Investigation of Austenite and Martensite in Some Special Steels. Zenji Nishiyama. *Kinzoku no Kenkyu,* Vol. 11, Nov. 1934, pages 529-538. In Japanese. Chromium steels containing 2-5% Cr and 0.8-1.12% C, Mn steels containing 1.19-10.03% Mn and 0.44-1.17% C, and Ni steels containing 4.48-10.02% Ni and 0.54-1.12% C were quenched in vacuum. About 0.2 mm. of the surface of the steels was dissolved by HNO_3. The crystal structure of the austenite and the martensite contained in the special steel was determined by X-rays, using a Seemann-Bohlin camera. The results are as follows: The austenite has a face-centered cubic lattice, and the martensite in quenched steels or in steels quenched and cooled in liquid nitrogen has a body-centered tetragonal lattice. Their lattice constants vary with C content in the same way as in the case of C steel. The martensite-like structure in quenched and tempered high Mn steels is not really the martensite as found in C steel, but it consists mainly of a hexagonal phase as present in the binary alloys of Fe and Mn. KT (10)

Determination of Structure as an Aid in Alloy Research (Strukturbestimmung als Hilfsmittel der Legierungsforschung). E. Schmid. *Berg- und Hüttenmännisches Jahrbuch,* Vol. 82, Sept. 28, 1934, pages 126-132. The importance of the use of X-ray and electron-ray interferences in determining the structure of elements besides the usual means of thermal, microscopic and physical testing is emphasized. Ha (10)

On the Nature of the Solid Solution of Aluminium in Silver. Sadajirô Kokubo. *Kinzoku no Kenkyu,* Vol. 11, Mar. 1934, pages 128-133. In Japanese. *Science Reports Tohoku University,* Vol. 23, Mar. 1934, pages 45-51. In English. The solid solution range of Ag and Al was reviewed, especially in the range of 4.5% Al. The specific gravity measurements by R. T. Phelps and W. P. Davey did not coincide with those calculated from the lattice constant. The author investigated this point, with the following result. If all the added aluminium (4.5%) is assumed to be dissolved in solid silver, the lattice parameter of the solid solution would be 4.049 A.U., according to Phelps and Davey. Using this value, the calculated density is 9.450, while that measured is 9.3608 (the difference, 0.95%). This value can be increased to 9.4128 by vacuum heating and compression (difference from calculated value, 0.4%). By repetition of this treatment, the difference could be decreased to 0.3%. The author ascribed this difference to the presence of Al_2O_3. KT (10)

X-ray Investigation on the Thermal Expansion of Solids, Part 2. Gunji Shinoda. *Memoirs of the College of Science, Kyoto Imperial University,* Series A, Vol. 17, Jan. 1934, pages 27-30. (In English.) The thermal expansion coefficients of Mg, Cd, Zr, and Co were determined by an X-ray method substantially the same as that described in the previous report (Part 1), but a new X-ray tube was constructed to take Debye-Scherrer photographs with a large angle of reflection. The following results were obtained: Mg ($\alpha_{\parallel} = 23.8 \times 10^{-6}$, $\alpha_{\perp} = 23.5 \times 10^{-6}$, $\alpha = 23.6 \times 10^{-6}$, Cd ($\alpha_{\parallel} = 50.0 \times 10^{-6}$, $\alpha_{\perp} = 17.9 \times 10^{-6}$, $\alpha = 28.6 \times 10^{-6}$), Zr ($\alpha_{\parallel} = 2.5 \times 10^{-6}$, $\alpha_{\perp} = 14.3 \times 10^{-6}$, $\alpha = 10.4$) and Co ($\alpha_{\parallel} = 16.1 \times 10^{-6}$, $\alpha_{\perp} = 12.6 \times 10^{-6}$, $\alpha = 13.8 \times 10^{-6}$). $\alpha_{\parallel}$ and $\alpha_{\perp}$ and α show the thermal expansion coefficients parallel and perpendicular to the hexagonal axis and the linear expansion coefficient respectively. Co has an allotropic transformation at 450°C. and α-Co which is stable below this temperature changes to β-Co with a face-centered-cubic lattice at this temperature. Therefore this transformation is similar to that of thallium in the previous paper, and c/a at this temperature must be 1.633. But as c/a of α-Co at room temperature is 1.633, $\alpha\|$ and α_1 must be nearly equal. HN (10)

The Binary Systems Iron-copper and Iron-antimony (Die Zweistoffsysteme Eisen-Kupfer und Eisen-Antimon). R. Vogel & W. Dannöhl. *Archiv für das Eisenhüttenwesen,* Vol. 8, July 1934, pages 39-40. The binary systems were examined preparatory to a study of the ternary Fe-Cu-Sb system. Proposed new diagrams of the two systems are shown. In the Fe-Cu system the closed field with two liquids in the melt, according to A. Müller, is indicated, but 20°C lower. The solubility of Cu in γ-Fe at 1477°C is 8% and *increases* with falling temperature to 8.5% at 1094°C. In the Fe-Sb system the region 55-65% Sb received attention; here a solid solution field exists touching the melt at 1018±3°C at 63.5% Sb. The maximum solubility of Sb in γ-Fe is 2%. SE (10)

Aluminum-bronze Wire (Filiazioni alluminio-rame). A. Vivanti. *Alluminio,* Vol. 3, Sept.-Oct. 1934, pages 268-280. By drawing at 1200°C., all the constituents of the system Cu-Al have been obtained. Besides those indicated by Stockdale (*Journal Institute of Metals,* Vol. 28, 1922, page 273, and Vol. 31, 1924, page 275) the zones $\alpha + \beta$, $\beta + \delta$ also exist. The eutectic ($\theta + \kappa$) when heated to 1000°C., loses its normal eutectic structure; when reheated to 650°C., however, it again assumes the eutectic structure. Under the above conditions, the Cu absorbs Al much more readily than Al absorbs Cu. AWC (10)

The Widening of the Debye-Scherrer Lines on X-Ray Photograms of Metals after Cold Working and Annealing (Ueber die Verbreiterung der Debye-Scherrer Linien auf den Röntgenogrammen von Metallen nach Kaltbearbeiten und Glühen). S. Konobejewski & T. Selisskii. *Physikalische Zeitschrift der Sowjetunion,* Vol. 4, No. 3, 1933, pages 459-480. The following were investigated: Mg, Elektron, A2M, (Al-Zn-Mg alloy) Al, Zn, Fe and Cu. Below the recrystallization point of Mg the width of the lines was found to be an exponential function of the annealing time. For Elektron, a triplet instead of the $K\alpha$ doublet was found for high-order lines, which phenomenon is ascribed to the diffusion of Al and Zn atoms in the deformed solid-solution lattice. It is theoretically derived that elastic strains can be relieved through a redistribution of the atoms of the components of the solid solution in certain temperature ranges. EF (10)

The Significance of Equilibrium Diagrams. J. S. Marsh. *Iron Age,* Vol. 133, Mar. 8, 1934, pages 25-25B. Abstract of paper read before the New York chapter of the American Society for Metals. Purpose is to simplify the elements of equilibrium diagrams by reviewing basic theory and by showing the close relationships among individual diagrams. VSP (10)

Alloys of Praseodymium and Silver (Le leghe tra praseodimio e argento). G. Canneri. *La Metallurgia Italiana,* Vol. 26, Oct. 1934, pages 794-796. Thermal and micrographic studies of the system Pr-Ag have established the existence of the following compounds: $PrAg_3$, melting at 956°C.; PrAg, melting at 948°C.; $PrAg_2$, unstable when melting, transition temperature 878°C. The alloys are all hard and brittle. AWC (10)

Atom Factor Determination on Metallic Beryllium (Atomfaktorbestimmung an metallischem Beryllium). W. Ehrenberg. *Zeitschrift für Kristallographie,* Vol. 89, Oct. 1934, pages 185-188. Determination of the F-curve of metallic 99.8% Be. Corroboration of Hartree's calculation of the atom factor. Effect of extinction on intensities from a powder preparation. The observed F values agree better with those derived for a Be atom than for a Be ion. EF (10)

Slip Bands and Twin-like Structures in Crystals. C. F. Elam. *Nature,* Vol. 133, May 12, 1934, page 723. Slip in beta copper-zinc crystals (body-centered-cubic structure) is in the [111] direction and on {110} planes. Twin-like structures form when slip occurs on two planes equally inclined to the axis (in tension). When rolled, the crystals cleave on {110} planes. CSB (10)

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On the Mosaic Structure of Crystals. HAROLD E. BUCKLEY. *Zeitschrift für Kristallographie,* Vol. 89, Sonderheft "Ideal & Realkristall," Oct. 1934, pages 221-241. In English. The different types of mosaic are reviewed: of these, those of Smekal & Zwicky are without reliable experimental basis and their theoretical conclusions have been disputed. The Darwin mosaic rests upon evidence of X-ray reflection from crystal surfaces. A number of experimental facts are given which show the difficulty of accepting the mosaic theory. The theory is discussed in the light of crystal growth, cleavage, etc. 63 references. EF (10)

A Theory of the Plasticity of Crystals. G. I. TAYLOR. *Zeitschrift für Kristallographie,* Vol. 89, Sonderheft "Ideal- & Realkristall," Oct. 1934, pages 375-385. In English. The fact that the macroscopic distortion of metallic crystals is a shear parallel to a crystal plane and in a crystal direction and the fact that this remains true even when the distortion is large shows that the plastic strain must be due chiefly to the sliding of one plane of atoms over its immediate neighbor in such a manner that the perfect crystal structure is reformed after each atomic jump. It is supposed that slipping occurs over limited lengths L of the slip plane, and it is shown that this type of plastic strain necessarily gives rise to elastic stresses near the 2 dislocations which occur at the 2 ends of each of these lengths L. The assumption that such dislocations will migrate through the crystal, owing perhaps to temperature agitation under the influence of even the smallest shear stress, leads to a definite picture of the mechanics of plastic distortion. The theory of strain hardening is expressible in quantitative form and gives a parabolic relationship between stress and plastic strain, namely $S/\mu\sqrt{s} = K\sqrt{\lambda/L}$ (μ = coefficient of rigidity, S = shear stress, λ one lattice distance along the slip plane, s = strain). This expression is in good agreement in the cases of metals which crystallize in the cubic system (data on Cu, Al, Fe, Au given). At room temperature, L was found to be of the order of 10^{-4} cm. which coincides with the observed spacing of faults in metals. According to this theory the part played by the system of faulting or mosaic structure is to limit the free motion of centres of dislocation. The actual strain takes place inside of the "blocks" of the mosaic structure and the crystallographic nature of the faults, i.e. whether they are boundaries of dendrites, a superstructure, or merely "pores," is immaterial to the theory. EF (10)

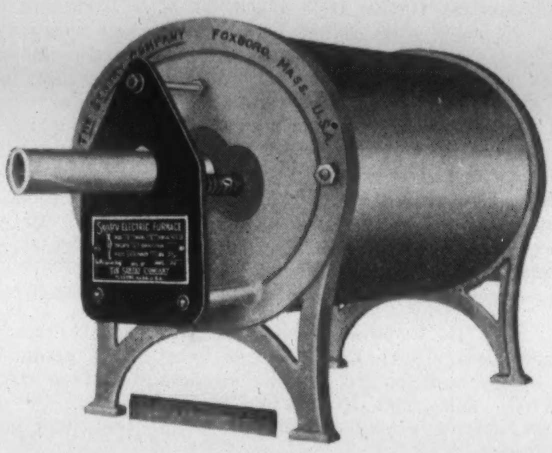
Disposition of Work Energy Applied to Crystals. C. G. MAIER & C. T. ANDERSON. *Journal of Chemical Physics,* Vol. 2, Aug. 1934, pages 513-527. Object of experiments was to secure data for an energy balance for the process of comminution of solids and a study of the thermodynamic properties of crystals as a function of particle size. Specific heat at low temperatures of finely drawn wires of Cu and Al in the annealed state were compared to those cold worked by referring to that part of the intrinsic energy represented by heat content. The heat and work during the drawing process of Cu and Al was studied. It has been shown that single crystals and hard drawn and annealed specimens of Cu and Al do not show differences of measurable entropy at 298° K. greater than a few tenths %. Comparison of work and heat in the deformation of metallic crystals of Cu and Al shows that only when carefully annealed samples are used can a discrepancy between work and heat be shown. For a given degree of cold working, this discrepancy is proportional to the mass of metal. It is not directly proportional to the degree of cold working but approximates constant value upon a certain indefinite degree of cold work. The hypothesis that the process of cold working produces a change of state of part of the metal is the only one fitting the experimental facts, including the density relations. The use of chemically pure metal did not eliminate parasitic e.m.f.'s nor residual effects and since these could be due only to inhomogeneities, it is concluded that the inhomogeneity is physical. A Zn wire containing 0.05% Pb is highly ductile at liquid air temperatures, contrary to unannealed wires of spectroscopically pure Zn, which are extremely brittle. This brittleness is not due entirely to the properties of normal Zn but the ω form produced. Thoroughly annealed wire (recrystallized) was brittle because of grain growth. Cast rods of purest Zn cannot be directly drawn but a small amount of swaging produces ductility so that a ¼ in. rod can be drawn after swaging to No. 32 wire without annealing and with an apparent increase of ductility. The hypothesis supposes the ductility to be due to the ω form in the spectroscopically pure metal and the Pb in the intercrystalline slip planes when the impure wire was made. The amount of the ω-phase metal is evaluated by 2 independent methods but no satisfactory confirmation is found for the hypothesis that the ω phase is essentially supercooled liquid as suggested by Beilby. (Aggregation and Flow of Solids, London, 1921.) EF (10)

A Simple Determination of the Space Orientation of Crystals (Eine einfache Bestimmung der räumlichen Orientierung von Kristallen). H. ECKSTEIN & W. FAHRENHORST. *Zeitschrift für Kristallographie,* Vol. 89, Nov. 1934, pages 535-528. Critically discussing the methods of Polanyi, Gross, Schiebold-Sachs, a new way is pointed out which requires 1 rotating-crystal photograph and an arbitrary Laue photograph. Whereas the Schiebold-Sachs method confines itself to cubic and hexagonal structures, the new method is even applicable to triclinic crystals. EF (10)

Illumination in Metallography. A. FISHER. *Machinery,* London, Vol. 44, Sept. 13, 1934, pages 711-714. General. WB (10)

Various Methods of Attacks in Crystallographic Investigations. J. D. H. DONNAY, G. TUNELL & T. F. W. BARTH. *Journal Mineralogical Society of America,* Vol. 19, Oct. 1934, pages 437-458. Scope of this paper lies wholly in geometrical and structural crystallography and deals with the directions of the crystal planes expressing the 5 known discontinuous vectorial properties of crystals: rate of growth, cohesion, twinning, gliding and X-ray diffraction. Goniometric determinative method, morphological description, X-ray analysis and their interrelations are discussed. Preliminary results obtained by one of the authors prove that for chemical elements, morphologic and structural lattices coincide. Examples: Cu, Ag, Au, Al, Ge, Th, C (diamond), Si, Pb, Rh, Pd, Ir, Pt. All have the octahedron as their dominant form, hence their Haüy-Bravais lattice is face-centered, so is also their structural lattice. EF (10)

A New Metal Microscope (Ein neues Metallmikroskop—das Metallmikroskop M III). HUGO FREUND. *Die Giesserei,* Vol. 21, Nov. 23, 1934, pages 507-508. For the needs of small plants and laboratories for routine and commercial purposes. Ha (10)



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Constitutional Diagram of the System Copper-Indium (Das Zustandsdiagramm des Systems Kupfer-Indium). FRIEDRICH WEIBKE & HANS EGGERS. *Zeitschrift für anorganische und allgemeine Chemie,* Vol. 220, Nov. 17, 1934, pages 273-292. Complete diagram set up by thermal, microscope, and X-ray analyses. Phases found are: α-phase, a solid solution of In in Cu saturated at 715° C. with 16.0%, at 574° C. with 19.2%, and at 20° C. with 6.5% In. Cu lattice is greatly widened by In. β-phase, existence range about 32% In above 574° C. with a eutectoid decomposition to ($\alpha + \delta$) at this temperature, is retained at room temperature by quenching (as with β-brass types). Simplest formula is Cu_4In. γ-phase is stable only above 630° or 616° C. (unquenchable). Homogeneity range is about 3% around 43% In. δ-phase is stable at room temperature from 42.3 to 44.5% In. The cubic structure is similar to γ-brass types. ϵ-phase is stable only at high temperatures and has a narrow homogeneity range at 45% In. At 615° C., eutectoid decomposition into ($\delta + \eta'$) occurs. η-phase is stable at room temperature (46.7 to 53.5% In.). At 389° C., $\eta \longrightarrow \eta'$ transformation occurs; a possible formula is Cu_2In. ϕ-phase has a narrow homogeneity range of 55.3-55.9% In at room temperature. Properties of Cu-In alloys are similar to those of alloys of Cu with Ga, Zn, Sn, Al. In the α-solid-solution range, the color goes from Cu to bronze (5-10% In) and gradually to brass color (up to 18% In). Heterogeneous ($\alpha + \delta$) alloys become brighter yellow with increase in δ phase. The silver-colored δ phase is very hard and brittle. This hardness is carried over in the ($\alpha + \delta$)-solid-solution range which, because of the simultaneous presence of a very hard and a relatively soft component, indicates a high tensile strength. The η phase is brittle and similar in color to δ-phase. Alloys with ϕ-solid solution are soft and easily deformed. From 60% In upward, the properties become more like In, because of increase in (ϕ + In) eutectic. Color from 54% In on is matte gray and metallic luster of In occurs only above 90% In. Investigation was based on 71 Cu-In alloys. WB (10)

The Intensities of X-ray Spectra and the Imperfections of Crystals. R. W. JAMES. *Zeitschrift für Kristallographie,* Vol. 89, Oct. 1934, *Sonderheft "Ideal- & Realkristall,"* pages 295-309. In English. Summarizes the evidence for perfection in the structure of actual crystals which may be obtained from a quantitative study of the intensity with which they reflect X-rays. Comparison of the theoretical derivations with actual measurements show very definitely that the majority of real crystals have a texture which is something between the 2 extreme types, but that most of them approximate more closely the mosaic type than the ideally perfect type. The observed integrated reflections for Al are altogether too high for the perfect crystal formula. The observed value for (111) for example is about 30 times that calculated for the perfect crystal. The agreement between the observed values and those calculated from the mosaic formula is surprisingly good. EF (10)

Microchemical Analysis of Plane Polished Surfaces by Means of Monochromatic X-ray Images. L. v. HÁMOS. *Nature,* Vol. 133, Aug. 4, 1934, page 187. A crystal can be arranged to form, by diffraction, a series of images of a polished specimen, each image being made by X-rays characteristic of a single element in the specimen (fluorescent X-rays). Thus the distribution of elements throughout the specimen may be determined. Suggested for study of ores, alloys, and reactions in the solid state. CSB (10)

11. PROPERTIES OF METALS AND ALLOYS

Measurement of Internal Friction of Metals (Ueber die Messung der inneren Reibung von Metallen). A. Rademacher & F. Sauerwald. *Mitteilungen aus den Forschungsanstalten des GHH-Konzerns,* Vol. 3, Oct. 1934, pages 124-140. The internal friction of a liquid, or of a liquid metal, is of vital importance in all cases where matter is to be transported from place to place within the liquid mass; it is a force which tends to quiet the motions within the liquid and can be defined by the internal friction coefficient, i.e. that force per unit of area which is required to produce a difference of velocity equal to 1 between 2 parallel planes having the distance 1 from each other. The methods of measuring this coefficient are reviewed and described, their theoretical principles explained. Flow-viscosimeters were found the most convenient and practical instruments giving best results, for they can be successfully applied for liquids with high surface tension and at relatively high temperatures. Results are shown in curves giving the friction coefficient in g./cm. sec. for metal baths of different temperature, velocities and pressures. Ha (11)

Book of A. S. T. M. Tentative Standards, 1934. American Society for Testing Materials, Philadelphia, 1934. Cloth, 6 x 9 inches, 1257 pages. Price $8.00.

The 1934 edition contains 236 tentative standards. Of these 48 are included for the first time, while some 60 were revised this year and are given in their latest approved form. A general classification of the items, with the number in each group follows:

Ferrous metals	25
Non-ferrous metals	25
Cementitious, ceramic, concrete and masonary materials	48
Paints, varnishes, lacquers and paint materials; waterproofing and roofing materials	30
Petroleum products and lubricants	13
Road Materials	31
Rubber products; textile materials; electrical insulating materials	42
Miscellaneous materials and general methods	22

The new tentative specifications of interest to the readers of *Metals & Alloys,* and published for the first time in 1934 cover the following ferrous and non-ferrous materials:—Electric-fusion-welded steel pipe for high-temperature and high-pressure service; alloy-steel castings for valves, flanges and fittings for service at temperatures from 750 to 1100 F.; and for the same temperature range, seamless alloy-steel pipe; sheet-copper silicon alloy; copper-silicon alloy rods, bars and shapes, and plates and sheets; also, magnesium-base alloy ingot for remelting, and magnesium-base alloy die castings. Richard Rimbach (11) -B-

New American Standards. *Engineer,* Vol. 158, Oct. 19, 1934, pages 393-394. Comments on tentative specifications put out by the A. S. T. M. covering alloy steel castings for valves, flanges and fittings, seamless alloy steel pipe for high temperature use and Cu-Si alloy, Cu-Si alloy rods, bars and shapes. LFM (11)

Conductivity of Metals. N. F. Mott. *Proceedings Physical Society,* London, Vol. 6, Sept. 1934, pages 680-692. A theoretical discussion of the electrical resistance of pure metals with reference to their place in the periodic table, to their behavior under pressure at high and low temperatures and to the effect of impurities. JCC (11)

Investigation of the Strength Properties of Metal Tubes Under Internal Pressure (Versuche uber die Festigkeitseigenschaften von Metallrohren bei der Beanspruchung durch Innendruck). E. Siebel & E. Kopf. *Zeitschrift für Metallkunde,* Vol. 26, Aug. 1934, pages 169-172. A mathematical treatment of the relation between the flow and the longitudinal, tangential and radial stress in a metal specimen is given. Soft steel, lautal, Cu, brass and Pb tube specimens were tested in tension and under internal pressure, whereby it is shown that: in steel the elastic limit and the ultimate strength are only slightly lower when tested under internal pressure than under tension, while the elongation is markedly lowered; in non-ferrous metals the elastic limit (2% elongation), ultimate strength and elongation are all lower in the pressure tests. The ruptures in the tubes were longitudinal in all cases. An apparatus for testing tube specimens under an internal pressure is described. FNR (11)

Research on Thermal Conductivity of Metals (Wire or Ribbon) at High Temperatures (Recherches sur la conductibilité thermique des métaux (fil ou ruban) a température élevée). M. Conard. *L'Aérotechnique* (*supplement to L'Aéronautique*), Vol. 12, Mar. 1934, pages 26-27. A brief illustrated, account of a method of determining thermal conductivities. The wire is mounted in an evacuated tube so that it can be heated by passage of an electric current either through it or through its end supports alone. JCC (11)

Plastic Deformation at a Hole in Steel and Magnesium Alloy Plates. R. H. Heyer & R. H. Burns. *Metals & Alloys,* Vol. 5, Dec. 1934, pages 284-287. 10 references. A preliminary report of the study of plastic flow of metal in region of a hole in a tensile member stressed beyond the point of local yielding from which the authors conclude, (1) the order of magnitude of local set at a hole in a plate when the net section is stressed to its yield point is less than 2% elongation, (2) with metals of gradually yielding stress-strain characteristics this set may be less than 1%, (3) drastic yielding in critical section occurs only when entire net section is stressed beyond the yield strength, and (4) entire mechanics of failure may depend on elastic and plastic properties which differ with different metals and alloys. WLC (11)

A New Light Alloy. *Machinery,* London, Vol. 44, Aug. 30, 1934, page 651; *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, page 477. The alloy made by J. Stone & Co., Ltd., under the name of Ceralumin "C" with Cu 2.5, Ni 1.5, Mg 0.8, Fe 1.2, Si 1.2, Ce 0.15 rest Al. It is claimed that Ce is effective in that Fe can be added for high mechanical strength while the embrittling Fe-Al constituent is suppressed. Ce also refines the macrostructure. The alloy can be heat treated and aged. GN + WB (11)

Buckling of Wires under their own Weight (Ueber das Knicken von Drähten unter dem Einfluss des Eigengewichts). A. Leon & E. Erlinger. *Annalen der Physik,* Series 5, Vol. 20, Sept. 1934, pages 635-645. The accuracy of formulas for calculating the length at which vertical wires, fixed only at the bottom, will buckle was checked. Greenhall's was found to be exact enough for practical purposes. Materials with high flow limit should be tested dynamically, the static test restricted to materials with a small range of deformation (Cu, Al). Curves and tables give numerical results for wires of Fe, steel, Cu, Al and Pb. Ha (11)

Method of Radiation-Calorimetry for the Thermal Conductivity of Metal Bars (Méthode du Radiateur-Calorimètre, pour la Détermination de la Conductibilité thermique des Barreaux Métalliques). P. Vernotte. *L'Aerotechnique* (supplement to *L'Aeronautique*), Vol. 12, Mar. 1934, page 25. A brief note. The effect on the amount of power dissipated by a small electric furnace when a bar of metal is inserted is used to determine the thermal conductivity of the metal. For a brass bar, α was found to be 0.29 cal. deg.$^{-1}$cm.$^{-1}$sec.$^{-1}$ JCC (11)

Vibrating Properties of Metals at Different Temperatures. Mary D. Waller. *Proceedings Physical Society,* London, Vol. 46, Jan. 1934, pages 124-127. Includes discussion. The length of time for which an audible note persists when a suspended bar of metal is struck with a hammer is recorded. This may be taken as a measure of the internal friction. It is altered by heat treatment and mechanical working of the metal. The possible value of the method in detecting differences in physical properties is suggested. JCC (11)

11a. Non-Ferrous

A. J. PHILLIPS, SECTION EDITOR

Effect of Increase of Purity Upon Properties and Workability of Aluminum (Ueber die Auswirkung der Steigerung des Reinheitsgrades auf Eigenschaften und Verarbeitung des Aluminiums). H. Röhrig. *Aluminium,* Vol. 17, Oct. 1934, pages 79-84. Al products are at present divided in 4 groups of purity: 1st, with the sum of impurities greater than 1%; 2nd, where the sum is smaller than 1% and usually not more than 0.2%; 3rd, the sum is between 0.01 and 0.1% (Hoope's Al), and the 4th with less than 0.01% (French refined Al). Color and brightness of the casting skin changes with the degree of purity, brightness increases with it and the color becomes more Ag like due to the absence of impurities on the surface by inverse segregation, and to the oxide film which is the thinner the purer the metal. The tendency to transcrystallization, i.e. to form coarse crystals during solidification increases rapidly with purity. Fe reduces grain size more than Si. In order to avoid coarse structure which is undesirable from the point of view of working Ti is added in very small amounts which tends to produce fine grain and therefore facilitates quick dispersion of the heat in the metal so that low casting temperatures can be employed. Tensile strength and hardness decrease with increasing purity and plastic properties are increased. Fe increases hardness more than the same amount of Si. Recrystallization with coarse grain in annealing and working processes also is enhanced by greater purity, a fine grain can be produced by annealing in a salt bath with a rapid temperature increase beyond the temperature of beginning recrystallization. High electric conductivity requires high purity; Si is harmful and can be eliminated by addition of Ca, when $CaSi_2$ is precipitated. Chemical resistance is better with high purity but very finely distributed Fe and Si grains have a favorable effect. The improvement in refinability seems to be dependent on Fe content and on solubility of Si in Al which is maximum 1.65%; some alloys refine under formation of Mg_2Si. Ha (11a)

Young's Modulus of Aluminium Rod. M. Sugihara. *Memoirs of the College of Science. Kyoto Imperial University* Series A Vol. 17. Sept. 1934, pages 389-396. The writer measured Young's modulus of Al rods composed of the crystal grains of various sizes by the methods of elongation-testing and of acoustical vibration. It was found that the value of Young's modulus of Al remained nearly the same irrespective of the sizes of the crystal grains, but that the limit of elasticity decreased considerably with the growth of the crystal grains. HN (11a)

Studies on Cast Red Brass for the Establishment of a Basic Classification of Non-Ferrous Ingot Metals for Specification Purposes. C. M. Saeger, Jr. *Foundry Trade Journal,* Vol. 50, June 7, 1934, pages 359-361, 370; June 21, 1934 pages 395-398. American exchange paper read before the Annual Conference of the Institute of British Foundrymen held at Manchester June 5-7, 1934. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 456. CEJ (11a)

Diffusion of Gases Through Metals. C. J. Smithells & C. E. Ransley. *Nature,* Vol. 133, Nov. 24, 1934, page 814. Measurements on the diffusion of gases through metals are not generally made with proper regard for the adsorbed layer of gas on the surface; the effect of this factor on the diffusion equation is discussed. CSB (11a)

Absorption of Hydrogen by Nickel. J. Smittenberg. *Nature,* Vol. 133, June 9, 1934, page 827. Between 200° and 600°C. and at pressures below 0.2 mm. Hg. there is no measureable adsorption of H_2 on Ni, but there is appreciable absorption (homogeneous solution). The amount absorbed is proportional to the square root of the pressure, and increases with the temperature. CSB (11a)

Magnetism of Tin. S. Ramachandra Rao. *Nature,* Vol. 133, August 25, 1934, page 288. Colloidal particles of tin are diamagnetic, the diamagnetism increasing as the particle size diminishes; after melting and recrystallizing the tin becomes paramagnetic. CSB (11a)

Precipitation Hardening, Its Scope and Possibilities. Paul D. Merica. *Metal Progress,* Vol. 27, Jan. 1935, pages 31-35, 60. Discusses various age hardening alloys and their unique properties. WLC (11a)

Volume Changes Resulting from Diffusion in Connection with Inverse Segregation II (Volumenänderungen durch Diffusion im Zusammenhang mit der umgekehrten Blockseigerung II). C. Haase. *Zeitschrift für Metallkunde,* Vol. 26, Aug. 1934, pages 181-185. The study of the effect of volume changes in the solid + liquid region of alloy systems on the degree of segregation, using the experimental procedure described in a previous publication (Haase *Zeitschrift für Metallkunde,* Vol. 24, 1932, page 258), has been extended to include the following alloys: Cu-Ag(25%), Cu-Sn(10 and 20%)-P(0, 0.04 and 0.1%), Cu-Mn(10%), Al-Cu(6.5%), Al-Zn(15%), Cu-Al(8.5%), Cu-Si(5%), and Cu-Zn(10, 15 and 23%). It is concluded that, except in the cases of the Cu-Al and Cu-Si alloys, the inverse segregation is connected with volume changes within the metal itself during the course of solidification or reheating. The gas content and porosity also appear to influence volume changes occurring during reheating. It has been found impossible to differentiate completely between the volume changes resulting from released gases and those due to changes in the density of the metal. 13 references. FNR (11a)

Dynamic Stresses of Hoist Ropes (Dynamische Beanspruchungen von Förderseilen). H. Herbst. *Glückauf,* Vol. 70, Dec. 1, 1934. pages 1149-1154. The stresses occurring in the ropes of mining hoists are investigated and particular attention is called to the dynamic stresses due to vibrations. In selecting material for such ropes the vibrational stresses peculiar to the kind of operation must be taken into account. Ha (11a)

Aluminium Alloys and Improved Methods of Manufacture. W. C. Devereux. *Metallurgia,* Vol. 11, Dec. 1934, pages 49-52. Production and heat treatment of Al castings are discussed. Some precautions to be observed in working wrought alloys are given. JLG (11a)

Silumin Gamma (Silumin-Gamma). J. Dornauf. *Aluminium,* Vol. 17, Sept. 1934, pages 26-31. Silumin-gamma is an Al-Si alloy with a small addition of Mn and Mg (amount not given); it possesses good castability, high corrosion resistance and toughness. The heat-treatment consists in annealing for 3-4 hrs. at 530° C., quickly quenching in cold water. It is then (at any time afterwards) tempered 20 hrs. at 150° which temperature must be kept constant within ± 5° C. The mechanical properties are

	elast. limit kg./mm.^{2}	tens. strgth. kg./mm.^{2}	elong. %	hardness kg./mm.^{2}
sand castings	18-25	25-29	4-0.5	80-100
chill mold castings	20-28	26-32	1.5-0.5	85-110
die castings	—	30-37	1-1.5	110-130

A table giving the actual values for wires from 8 to 14 mm. diam. and for some rectangular sections is added. Ha (11a)

Permeability to Hydrogen of Nickel, Copper and Some Alloys (Wasserstoffdurchlässigkeit von Nickel, Kupfer und einigen Legierungen). W. Baukloh & H. Kayser. *Zeitschrift für Metallkunde,* Vol. 26, July 1934, pages 156-158. The permeability of hydrogen through a specimen tube sealed into a clear quartz tube enclosed in a resistance furnace was measured volumetrically, the temperature and pressure being regulated. The permeability through Ni decreases with increasing metal thickness and increases with rising pressure and temperature, but drops to a common low value for all temperatures in the course of time. There is no apparent relationship between grain size and permeability. Additions of Cr and of Cu to Ni lower its hydrogen permeability progressively. In their order of decreasing permeability the metals studied were Ni, Ni-Cr alloys, Ni-Cu alloys, Fe and Cu. There seems to be no connection between solubility for hydrogen and permeability. No explanation is offered for any of these observations. 8 graphs. FNR (11a)

Conductivity of Tellurium. C. H. Cartwright & M. Haberfeld. *Nature,* Vol. 133, Aug. 25, 1934, page 287. Measurement of conductivity of tellurium as a function of purity indicates that the conductivity can be entirely ascribed to the impurities. CSB (11a)

New Role of Titanium in Steels and Alloys. George F. Comstock. *Metal Progress,* Vol. 27, Jan. 1935, pages 36-41. Discusses new uses of Ti in age hardening alloys of Ni and Fe. its affinity for C as aiding in eliminating intergranular corrosion of 18-8 Cr-Ni steel, prevention of air hardening of 5% Cr steel castings, control of grain size in forging steels, graphitizing action in cast iron and control of grain size in 6% Cu, 1.2% Si, Al alloys. WLC (11a)

Calculation of Physical Constants of Quasi-Isotropic Poly-Crystals (Zur Berechnung physikalischer Konstanten quasiisotroper Vielkristalle). W. Boas & E. Schmid. *Helvetia Physica Acta,* Vol. 7, Aug. 15, 1934, pages 628-632. Based on the evaluation method of Huber & Schmid the elastic moduli of quasi-isotropic poly-crystals of Al, Cu, Ag, Au, α-brass α-Fe, Mg, Zn, Cd are derived from the properties of single crystals and found to be in good agreement with direct measurements. The utilization of the method for theoretically deriving other physical constants (thermal expansion coefficient, specific electric resistance) of Mg, Zn, Cd, β-Sn also yielded suitable values. EF (11a)

Plasticity of Bismuth due to Occluded Gas. W. F. Berg. *Nature,* Vol. 133, June 2, 1934, page 831. Bi crystals prepared by the Czochralski method are ductile in tensile tests whereas those prepared by the Bridgman method are brittle. Suggestion is made that this is because the former contain gas, which is experimentally estimated to be present in quantities of about 3×10^{-4} molecules of gas per atom of Bi. CSB (11a)

Zinc and Its Alloys (Zink und seine Legierungen). Arthur Burkhardt. NEM Verlag, Berlin, 1934. Paper, 8 1/4 x 11 3/4 inches, 34 pages. Price 3.40 RM. Reprint from *Metallwirtschaft.* See *Metals & Alloys,* Vol. 6, Jan. 1935, page MA 31. (11a) -B-

Special Alloys (Speziallegierungen). *Zeitschrift für die gesamte Giessereipraxis,* Vol. 55, Nov. 11, 1934, page 477; Nov. 25, 1934, page 497. Composition, properties and application of the following alloys are considered: (1) Ferrul alloy, a Zn rich, Pb and Al bearing brass alloy containing 54.6% Cu, 40% Zn, 5% Pb and 0.4% Al. Ferrul possesses very low viscosity in liquid state and therefore fills perfectly any intricate mold. (2) Ferry metal, 2 different alloys are marketed under this name, an electric resistance alloy with 55% Cu and 45% Ni and a Pb rich alloy with 2% Ba, 1% Ca and 0.25% Hg. The latter is used for bearings but also as solder. (3) Fletcher's bearing metals are Al base alloys, composition either 92% Al, 7.5% Cu, 0.25% Sn or 90% Al. 7% Cu, 1% Zn. (4) Flint alloy, heat and corrosion resistant Fe-Cr alloy with 83% Fe, 12.5% Cr, 3% C, and 0.5% Si. (5) Fourdrinier metal, an alloy containing 80% Cu, 20% Zn. (6) French brass ("Potin Jaune") containing 71.9% Cu 24.9% Zn, 1.2% Sn and 2% Pb, can be easily machined and has been extensively used in France for art castings. GN (11a)

Magnetic, Electrical and Spectrographic Experiments on Gold-Silver Alloys (Magnetische, Elektrische und Spektrographische Untersuchungen an Gold-Silberlegierungen). H. Auer, E. Riedl & H. J. Seeman. *Zeitschrift für Physik,* Vol. 92, Nov. 26, 1934, pages 291-302. Susceptibility and resistance measurements of the above alloys showed less than 1% variation after samples were treated as follows: (1) Annealed in vacuo. (2) Annealed in N_2. (3) Remelted in vacuo. FHC (11a)

Cooling of Metals by Air (Étude du refroidissement des métaux par l'air). P. Vernotte & E. Blouin. *L'Aérotechnique* (supplement to *L'Aéronautique*), Vol. 12, Mar. 1934, pages 25-26. A method of determining the coefficient of thermal exchange between a block of Al and currents of cold air passed at various speeds along a hole cut through its center is described, and the results shown graphically. JCC (11a)

Reflecting Properties of Aluminum and Its Alloys as Dependent on the Surface Treatment (Die Spiegelungseigenschaften von Aluminium und seinen Legierungen in Abhängigkeit von der Oberflächenbehandlung). Hase. *Aluminium,* Vol. 17, Sept. 1934, pages 20-25. Optical properties, particularly absorption of the different spectral colors and the regular and diffuse reflective capacity of Al and its alloys "pantal" and "polital" were found to make these metals suitable for use as reflectors; they are not like Cu, Au and brass in showing a selective reflective power for certain color ranges, and red is reflected about 15% better than blue light. Diagrams in polar coordinates show the reflectivity of the 3 materials under different conditions of polish and lacquer coatings. Ha (11a)

Strength of Metal Single Crystals. R. Roscoe. *Nature,* Vol. 133, June 16, 1934, page 912. The critical shear stress necessary to cause slip on a glide plane of Cd depends on the condition of the surface. A surface film of oxide that in some way hinders the initiation of slip seems to be responsible; brushing an oxidized surface with dilute H_2SO_4 reduces the critical shear stress from 120 g./mm.^{2} to 60 g./mm.^{2} Single crystals of absolutely pure Cd might have zero critical shear stress, since vacuum distilled cadmium has a value as low as 13.7 g./mm.^{2} CSB (11a)

Properties of the Platinum Metals. I—Strength and Annealing Characteristics of Platinum, Palladium, and Several of their Commercial Alloys. E. M. Wise & J. T. Eash. *Metals Technology, American Institute Mining & Metallurgical Engineers, Technical Publication* No. 584, Dec. 1934, 12 pages. Commercial metals and alloys were studied. They were C. P. Pt, No. 1 Pt, 95Pt-5Ir, 90Pt-10Ir, 80Pt-20Ir, 90Pt-10Rh, 75Pt-20Pd-5Rh, 95Pt-5Ni, No. 1 Pd, 95Pd-3Rh-2Ru, 95Pd-1Rh-4Ru. The materials were in the form of wires 0.050 in. in diameter that had been cold drawn from a diameter of 0.071 in. The wires were annealed for 5-min. periods at temperatures up to 1200°C. and their tensile properties determined. From these results recommended annealing temperatures for each material are given. Recommended temperatures are from 900 to 1300°C. Tensile strengths after annealing at these temperatures range from 36,000 lb./in.^{2} for Pt to 140,000 lb./in.^{2} for the 80-20 Pt-Ir alloy. JLG (11a)

On the Effect of the Beta Constituent Upon the Properties of 63/37 Brass. J. Verö. *Mitteilungen der berg- & hüttenmannischen Abteilung der königlich-ungarischen Hochschule für Berg- & Forstwesen zu Sopron, Hungary,* Vol. 5, 1934, pages 1-7. In English, German summary. The presence of the β constituent in 63/37 brass results in a loss of corrosion resistance and elongation which were found to be proportional to the amount of β crystals present. The statement of Ostermann (*Zeitschrift für Metallkunde,* Vol. 19, 1927, page 349), concerning particularly harmful effect of minute quantities of β and unusually detrimental influence of the "critical annealing temperature of 650°C." could not be corroborated. The presence of the β phase did not affect ultimate strength and reduction of area. WH (11a)

Remarkable Optical Properties of the Alkali Metals. R. de L. Kronig. *Nature,* Vol. 133, Feb. 10, 1934, pages 211-212. Unusual optical properties discovered by R. W. Wood (*Physical Review,* Vol. 44, 1933, page 353) are discussed from standpoint of electron theory. CSB (11a)

Optical Properties of the Alkali Metals. J. Hurgin & N. Pisarenko. *Nature,* Vol. 133, May 5, 1934, page 690. Additional discussion of the theory. CSB (11a)

Vapor Pressure of Potassium Amalgams. H. H. v. Halbon, Jr. *Nature,* Vol. 133, Mar. 24, 1934, page 463. Vapor pressures of Hg over potassium amalgams were measured. Renewal of surface by careful stirring gives pressure corresponding to Raoult's law, but if the liquid alloys are not stirred or if impurities are present, much lower pressures are found. CSB (11a)

Elektron, the Lightest of the Useful Metals (Elektron, das leichteste Nutzmetall). *Montanistische Rundschau,* Vol. 26, Nov. 16, 1934, 3 pages. Gives physical and chemical properties of the various types of high-magnesium alloys included under the trade name Elektron. Corrosion resistance may be increased by pickling in chromate solution. Many protective lacquers and paints are also available. Discusses methods of fabrication and cites numerous important practical applications in the transportation field and in chemical industry. BHS (11a)

11b. Ferrous

E. S. DAVENPORT, SECTION EDITOR

Naturally Alloyed Pig Iron, Cast Iron and Steel Castings. S. S. Nekryty. Amtorg Trading Corporation, New York, 1934. Paper, 6 x 9¼ inches, 25 pages. Paper presented at the Fifth International Congress of Foundrymen, 1934, and at the Second U.S.S.R. Congress of Foundrymen, 1934. Additions of Ni and Cr to the molten metal did not always give uniform results. Pig iron from the Orsk-Khaliliov deposit (U.S.S.R.) ore, containing Si as required, Mn 1.0, S 0.008 to 0.033, P 0.24 to 0.37, Cr 2.4 to 3.2, Ni 0.70 to 1.2, Ti 0.17 to 0.57, V 0.12 to 0.26, Co 0.03 percentages, was used as a source of Ni and Cr. In calculating the metal charge, where C ranged from 3.2 to 3.4% and the wall thickness was around 0.6 in., the following formula was used:

$$K = \frac{(2 \times \%\,\mathrm{Si}) + (\%\,\mathrm{Ni})}{(1.5 \times \%\,\mathrm{Cr}) + (\%\,\mathrm{Mn})} = 3 \text{ to } 3.5$$

where K was coefficient of equivalency of graphitization forces. For castings with greater wall thickness the formula was:

$$K = \frac{(2 \times \%\,\mathrm{Si}) + (\%\,\mathrm{Ni})}{(\%\,\mathrm{Cr}) + (\%\,\mathrm{Mn})} = 3 \text{ to } 3.5$$

If total C content varied it was taken into account that one part of C was equivalent to 5 or 6 parts of Ni. K was lower than 3 if the castings did not require machining. In casting, this iron was 40° to 50° C. colder optically than it was actually, it filled the mold completely but required about twice as long a time to pour, and during the freezing period it did not possess any "surface play." Castings made with varying proportions of this naturally alloyed pig iron in the mixture showed about 60% improvement in abrasion tests, great improvement in heat resistance, and, with additions up to 27%, better impact strength than similar castings made with ordinary pig iron. Orsk-Khaliliov pig additions created favorable conditions for heat treatment of the castings. Artificial aging hindered the growth of the metal at increased temperatures. Normalizing improved both machineability and mechanical properties. Quenching and drawing protected the castings from creep and improved their resistance to fatigue. Very satisfactory results were also obtained by the use of this pig in the basic open hearth for the production of alloy steels. WHS (11b)

Wrought Iron and What Determines Its Quality. *Iron Age,* Vol. 134, July 19, 1934, pages 26-27, 78. From a report submitted by Committee A-2 of the American Society for Testing Materials on wrought Fe. Deals with the physical properties, chemical composition and internal structure as means of indentifying the material among other ferrous products. VSP (11b)

American Specifications for Steel. *Engineer,* Vol. 158, Oct. 5, 1934, page 343. Brief summary of specifications adopted by the American Society for Testing Materials. LFM (11b)

Cast Iron (Werkstoff "Gusseisen"). Erich Becker. *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Nov. 18, 1934, page 739. Discusses the effect of various alloying constituents on the mechanical and physical properties of cast Fe and the precautions taken in alloying in the ladle. GN (11b)

Age Hardening of Materials. H. M. Boylston. *Industrial Heating,* Vol. 2, Jan. 1935, pages 9-13. Changes occurring in the physical properties of materials due to aging, i.e., with passage of time, are discussed and investigations into the causes reviewed. The influence of C, N, Co and Mo on aging is explained by the work of various investigators. 13 references. Ha (11b)

The Stresses in Thick-Walled Cylinders of Mild Steel Overstrained by Internal Pressure. Gilbert Cook. *Institution of Mechanical Engineers, Proceedings,* Vol. 126, Jan.-Mar. 1934, pages 407-455. Theoretical and experimental investigation of stress distribution across the walls of thick cylinders of mild steel when the internal pressure is such that the elastic limit of the material is exceeded and overstrain occurs. Calculation and experiment agreed very well with the assumption that the constant shear stress is equal to the shear stress observed during plastic yield in tension. The maximum shear stress in the elastic region in partially overstrained cylinders varies as overstrain proceeds. The effect of overstrain at the internal surface is to reduce the circumferential tensile stress and to set up an axial compressive stress. With sufficient wall thickness all 3 stresses become compressive for pressures which still permit of the external portions remaining elastic. Ha (11b)

Properties of Bessemer Steel Dephosphorized by Tochinskii's Method. M. Aronovich. *Stahl,* Vol. 4, Aug. 1934, pages 70-91. In Russian. An investigation of 5 heats of Bessemer steel which were dephosphorized by pouring the steel into a ladle containing molten basic slag immediately after blowing. As compared to ordinary Bessemer steel these steels had a slightly decreased tensile strength and greatly increased elongation, reduction of area, and impact resistance. The impact resistance was approximately the same as that of open-hearth steels of the same composition. Analysis showed very few slag inclusions (av. 0.0159%) which was confirmed by microscopic examination: HWR (11b)

High-Test Iron Supplied in Heat Treated or Alloy Form. *Steel,* Vol. 95, Nov. 12, 1934, pages 42-43. Fulton Foundry & Machine Co., Cleveland, O., heat treats Meehanite by preheating to 1000° F., raising the temperature to 1575° F., quenching in oil, and drawing at 1000°-1200° F., depending on hardness desired. When heat treated, tensile strength exceeds 75,000 lb./in.^{2} and the other physical properties are improved proportionately. Coefficient of friction is lowered, grain structure is refined, and the structure is all sorbite. Hardness is kept to a maximum of 280-300 Brinell, to keep machining costs low. Alloying elements are used most generally to obtain certain corrosion and chemical properties rather than physical properties. Certain Si-Cr combinations are used for heat-resisting services up to 1600° F. Ni-Cr combinations resist absorption of molten Al and corrosion in hot gases. Cr-Mo combinations produce very hard castings which are tough and strong. Applications are numerous. MS (11b)

A Review of Spring Wire Characteristics. C. T. Eakins. *Iron Age,* Vol. 134, Aug. 16, 1934, pages 16-19, 76, 78. Basic requirements for good spring spring steel wire is clean steel of uniform composition and physical properties. Steel wires most used in manufacture of springs are hard drawn, oil-tempered, music, annealed high-C alloy steel and stainless steel. Hard drawn wire is a basic open-hearth product. Tensile strength of hard drawn wire varies from 200,000 lbs./in.^{2} for large diam. to 300,000 lbs./in.^{2} for small diam. Its uses are in upholstering, toys, automobile industries, etc. Oil tempered wire is practically same as hard-drawn except C will average a little higher. Elastic limit of oil tempered wire is higher than hard drawn wire of corresponding diam. Music wire is the highest grade of commercial spring wire. It is made in electric furnace. Annealed high-C wire is used for springs that are quenched and tempered after forming. It is made from acid or open-hearth steel. Includes an extensive table giving the chemical and physical properties of the various kinds of wires. VSP (11b)

Effect of Manganese Content on Mechanical Properties of Rolled Steels. Report No. 3. Masatoshi Jô & Shun-ichirô Nagai. *Seitetsu Kenkyu (Metallurgy Reports from The Yawata Iron Works, The Nippon Seitetsu Co. Ltd., Japan),* No. 137, May 31, 1934, pages 1-20. Using more than 18000 specimens prepared from 4700 kinds of rolled basic open-hearth steels (0.08-0.60% C) at the Yawata Iron Works during last 7 years, the tensile strength was tested as rolled and annealed. Annealing was carried out as follows: the rolled specimens were heated at proper temperatures (A.S.T.M.) for 20-30 minutes and cooled slowly in ashes. With constant Mn content, the tensile strength of the annealed steels rises with increasing C content; rate of increase is more gradual than in the case of rolled steels. The following relation between C and Mn contents and tensile strength of the annealed steels was established: $T_A = 0.333\ C + 0.005\ CMn + 0.01\ Mn + 31$, where, T_A = tensile strength in kg./mm.^{2} of the annealed steel, C = C content in (%) × 100, Mn = Mn content in (%) × 100. This formula is applicable for steels containing 0.2 — 1.00% Mn. The relation between the strengths of the rolled and the annealed commercial steels, is given by the formula: $T_A = 0.8\ T_R + 7.5$, where T_R = tensile strength in kg./mm.^{2} of the rolled steel. The drop in tensile strength due to annealing, in rolled steels with similar tensile strength but different C and Mn contents, is more remarkable in the low C, high Mn steels than in the high C, low Mn steels. TS (11b)

Properties Extend Gray Iron Uses. W. Worley. *Foundry,* Vol. 62, July 1934, pages 23, 52. Some of the new applications demonstrate that usefulness of gray cast Fe need not be confined to uses where static loads prevail, or mass is requisite; with proper application of test data in design, dynamic loads may be sustained with safety. Extended uses of gray Fe castings are coming about through revised specification A48-32T of A.S.T.M. and authoritative data on mechanical properties published under the joint sponsorship of A.S.T.M. and A.F.A. in a symposium on cast Fe. Engineering classifications of gray Fe are based on tensile strength. The compressive strength is superior to structural steel and most other engineering materials. No satisfactory test for machinability has yet been devised. VSP (11b)

The Production of Specially Hard Cast Irons by Alloying and Heat-Treatment. W. T. Griffiths. *Foundry Trade Journal,* Vol. 50, April 12, 1934, pages 237-240, 248. Paper presented to the Lancashire Branch of Institute of British Foundrymen. The introduction of alloying elements or heat-treatment or a combination of both to harden the white iron matrix results in hardening cast iron. If cast iron is considered as a steel containing graphite flakes or iron carbide some of the principles of alloying and heat-treatment of steels will apply to cast-iron. The following conclusions were drawn: (1) Under the conditions adopted for this research, iron containing about 0.4% P, 0.1% S, 0.5% Mn and 0.5% Si gave a chill depth of 2 inches when the carbon was 2.9%; (2) Any increase or decrease in C content from 2.9% could be counterbalanced by the addition or withdrawal of ¾ as much Cr; (3) The addition of Ni could be counterbalanced by the addition of ¼ as much Cr; (4) Si present in excess of 0.5% could be balanced by the addition of ¾ as much Cr; (5) Mn present in excess of the amount required to neutralise the effect of S (in this case in excess of about 0.5%) had the same effect as ¼ the amount of Cr; (6) Mo had the same effect as 1/3 as much Cr. With a total alloy content exceeding 5.5% consisting of Ni, Cr, Mn and Mo a high hardness will be reached in spite of very slow cooling. Best hardness in castings cooled relatively rapidly is to be obtained with 3½% Ni, a low Si content and amount of Cr dependent on the C content with which the carbide is formed in such a manner as to develop the correct chilling characteristics. CEJ (11b)

Hardening of Ferrous Alloys by Beryllium (Cémentation des Alliages Ferreux par le Glucinium). Joseph Laissus. *Comptes Rendus,* Vol. 199, Dec. 10, 1934, pages 1408-1410. Studies of Fe-Be alloys show a solubility of Be in Fe and a eutectic consisting of a solid solution with the compound $FeBe_2$. The presence of C does not appear to influence these alloys. Be enters Fe in a manner similar to the cementation process. The surface of Fe is hardened by the penetration of Be and increased resistance to high temperatures and corrosion was observed. FHC (11b)

Analysis of Hard Metal Carbide Theory. Karl Schroeter. *Iron Age,* Vol. 133, Feb. 22, 1934, pages 21-23, 61. Reviews theories dealing with the internal behavior of Al and Mg-Si compounds and expands them to explain action of W-Co system. W and Co mixed in proper proportions, highly compressed and sintered in a crucible containing sufficient C, yield a product which is cemented W carbide. If fired ½ hr. at 800° C. hardness increases and temperature is then elevated steadily until about 1350° C. is reached. Analyzes the critical aging temperature and explains mechanism of cementing. Includes bibliography. VSP (11b)

Effect of Zirconium on Cast Iron. Rebecca Hall. *Foundry,* Vol. 62, Apr. 1934, pages 22-23, 54. Gives results of tests on the effect of different amounts of Zr on properties of cast Fe. Tests were conducted on an electric furnace Fe: C 2.85%; Si 1.92%; S 0.043%; Mn 0.58%; and P 0.06%. Zr additions between 0.10 and 0.50% claimed to be most beneficial for cast Fe. Zr tends to raise strength, deflection and drop test values, and to decrease modulus of elasticity. It has no appreciable effect on Brinell hardness. In small amounts its chief value lies in its ability as a purifying and deoxidizing agent and its power to graphitize white Fe. VSP (11b)

Thermal and Electrical Conductivities of Metals and Alloys: Part I. Iron from 0° to 800° C. A. W. POWELL. *Proceedings Physical Society, London,* Vol. 46, Sept. 1934, pages 659-679. Determinations of the thermal and electrical conductivities of Armco iron have been made by the National Physical Laboratory. A value of 0.177 c.g.s. units was obtained for the thermal conductivity at 0° C., falling to 0.071 c.g.s. units at 800° C. These values are higher than those usually accepted, probably on account of the greater purity of the Armco iron. A very pure chemically prepared iron was found to have a thermal conductivity of 0.194 c.g.s. units at 0° C. The Lorentz function of the Armco iron increased from 0.62×10^{-8} at 0° C. to 0.74×10^{-8} at 400° C., remaining constant at this value to 700° C. JCC (11b)

The Electrical and Thermal Conductivity of Cast Iron (Die elektrische und die Wärmeleitfähigkeit von Gusseisen). E. SÖHNCHEN. *Archiv für das Eisenhüttenwesen,* Vol. 8, Nov. 1934, pages 223-229. An ice-calorimetric comparative method and an absolute method using hollow cylinders, for determining thermal conductivity are described. The conductivities are lowered by dissolved alloying elements. Cementite lowers the conductivities strongly; temper carbon only slightly. As the proportion of graphitic carbon for a constant total carbon increases, the electrical conductivity decreases but the thermal conductivity increases, this being more pronounced the coarser the graphite. Si lowers the conductivity provided it does not raise the graphite content; if this is raised the thermal conductivity may increase. P decreases the conductivity; Cu gives a minimum at 1% Cu; Ni lowers the conductivity with constant graphite content. If Si is replaced by Ni there is an increase in conductivity to a maximum at about 3% Ni. The effect of Cr is not clear cut, but in general, it causes a slight increase in electrical conductivity and a decrease in thermal conductivity. SE (11b)

Manganese Improves Resilience. BERNARD THOMAS. *Heat Treating & Forging,* Vol. 20, Nov. 1934, pages 531-533. To show that Mn in hardening steels should be as high as possible without exceeding the limit at which brittleness may be expected, tests were carried out with steels containing (a) 0.54% C, 0.67% Mn, 0.036% S, and (b) 0.53% C, 0.81% Mn, 0.052% S. All test-pieces, in the form of strips 7 x 1 x ⅛ in., were heated together and quenched from 1450° F. into fused salt at 375° F. and tempered at 510° F. Bending loads were applied, by means of a Brinell machine, to the middle of the strips supported on knife-edge centers 6 inches apart. Permanent set and the load necessary to obtain a temporary deflection of 1.0 inch or fracture under load were read. Results showed that (b) averaged 52% greater strength and 63.7% greater resilience. MS (11b)

Notes on the Manufacture of Nickel-Iron Alloys and Their Relation to Modern Industry. G. R. WEBSTER. *Foundry Trade Journal,* Vol. 50, April 19, 1934, pages 254-255. Paper presented for "Short Paper Competition," London Foundrymen's Annual Meeting. Iron alloys with 30 to 36% Ni have low coefficients of expansion. These alloys with small percentage of Cr are used for springs in timing mechanisms. Alloys with a Ni content ranging from 40 to 46% have low expansion characteristics and are used for glass-to-metal joints. Alloys containing 48 to 50% Ni are used in lead or soda-glass to metal joints. 50% Ni material is used in transformer cores. Alloys containing 80% Ni with small percentages of other metals such as Cu, Cr, Mn, etc., have very high magnetic permeability. All Ni alloys can be forged and worked easily. Care must be taken in melting to avoid contamination; vacuum melting is useful. CEJ (11b)

Hysteresis Loss in Steel. E. C. WADLOW. *Electrical Review,* Vol. 115, Nov. 9, 1934, pages 639-640. Presents curves for various steels, of the relationship between hysteresis loss and magnetizing force over a range of values up to about 300 c.g.s. units per cm. Steels used were annealed 0.9% C, hardened 0.9% C, hardened and tempered 0.9% C, 6% Cr, 9% Co, and 36% Co. Shows that each steel will give optimum results only over a limited range of values of magnetizing force. For magnetizing forces up to about 200 c.g.s units per cm., energy loss per cycle per cc. is much greater, due to hysteresis, in W, Cr, and C steels than in the commonly used Co magnet steels. It is important that the heat treatment should be appropriate to the magnetizing force available in order that the steel may be used most effectively. MS (11b)

Wire Rope Research and Wire Rope Manufacture (Drahtseilforschung und Drahtseilherstellung). CARL SCHWIER. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Oct. 20, 1934, pages 1223-1225. Results of investigations on wire ropes are surveyed. Influence of exterior conditions (specific load, diam. of rope pulley, form of grooves) and of interior conditions (construction of the rope, kind of wire) on rope life is discussed. Galvanized wires behave, according to recent investigations, better than plain wires. A good, acid-free lubrication protects from rusting and reduces friction. Too many strands of thin wire are dangerous. The importance of twist-free ropes for use in aerial passenger lifts or conveyors is emphasized. Influence of manufacturing processes, acid or basic, and testing of properties of finished ropes is briefly reviewed. 26 references. Ha (11b)

"Heredity" in Cast Iron. H. W. GILLETT. *Metals & Alloys,* Vol. 5, Sept. 1934, pages 184-190. Correlated Abstract. Summarizes and refers to mass of work indicating that varying results are obtained due to variations in fuel, pig iron and other raw materials used in the cupola. Several theories on the effect of O_2 content and nuclei of undissolved graphite are discussed; their acceptance awaits more definite information including analytical evidence that compositions presumed to be identical are actually the same. Order of charging has been found by some workers to effect product as well as superheating and other melting variations. 45 references. WLC (11b)

Experiment on the Effect of Additions of High-Carburized special Pig Iron Upon the Resistance to Growth and Scaling of Gray Iron (Versuche über den Einfluss von Zusätzen eines hochgekohlten Spezialroheisens auf die Wachstums- und Zunderbeständigkeit von Grauguss). M. PASCHKE & H. SCHUSTER. *Die Giesserei,* Vol. 21, Nov. 9, 1934, pages 469-476. A special pig Fe of high C content (composition not given) was added in varying quantities to cast Fe which was subjected to repeated heating between 600° and 950° C. Dilatometric and metallographic examination established the very favorable effect of high additions, 50-80%, of the special pig Fe. Much greater resistance to scaling and less growth was observed due to the finer distribution of the graphite, the denser pearlitic basic structure, and the small amount of gas in the Fe. Ha (11b)

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Metallurgical Abstracts

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Permissible Stress Range for Small Helical Springs. F. P. ZIMMERLI. *Engineering Research Bulletin 26, University of Michigan,* July 1934, page 1-79. The available stress ranges to which commercial steels can be subjected, when tested in the form of small helical compression springs, was investigated on wires of different types of steel and diameters. Endurance limit in torsion, as measured by fatigue tests, was found, for a given spring steel, to be directly proportional to the ultimate torsional strength. When the ultimate torsional strength of a given steel was increased by lowering the drawing temperature the endurance limit was increased. No relation seems to exist between proportional limit in torsion and endurance limit. Variations in mill practice in the manufacture of spring steel often produce variations in fatigue properties of the material. Cold-drawn spring steel wire as now usually made has a lower stress range than heat-treated steel wire of the same ultimate torsional strength. Cr-V steel has the highest endurance limit of any of the steels tested; Si-Mn steel and high Mn-C steel are superior to straight C steel but not equal to Cr-V steel. Low C, 18% Cr, 8% Ni stainless steel has a fatigue resistance nearly as low as non-ferrous materials. Ha (11b)

New Nickel-Chromium Alloy Inconel (Neue Nickel-Chrom Legierung "Inconel"). *Korrosion und Metallschutz,* Vol. 10, Nov. 1934, pages 263-265; *Die Metallbörse,* Vol. 24, Sept. 15, 1934, pages 1178-1179; Sept. 22, 1934, pages 1210-1311. Mechanical and chemical behaviors of the alloy of 80% Ni, 14% Cr and 6% Fe are given in tables. M.p. is 1390° C. It has very good resistance to corrosion by the organic acids met with in foodstuffs, and by salt-containing vapors. Applications are reviewed; it can be forged. It is superior to 18/8 alloy with regard to atmospheric corrosion. It resists oxidation up to 1100° C. EF + Ha (11b)

12. EFFECT OF TEMPERATURE ON METALS AND ALLOYS

L. JORDAN, SECTION EDITOR

The abstracts in this section are prepared in co-operation with the Joint High Temperature Committee of the A.S.M.E. and the A.S.T.M.

Characteristic Features of the Resistance of Metals at High Temperatures (Les caractéristiques de résistance des métaux aux températures elevées). M. Ros & A. Eichinger. *Revue de Métallurgie,* Vol. 31, Oct. 1934, pages 460-470. Permanent deformation is caused by slipping along the slip planes; elastic deformation by distortion of space lattice. Permanent deformation for all temperatures depends on the comparative distortability of crystalline units alonog their 3 axes. Resistance to deformation by sliding along the slip planes is reduced by rise of temperature. At room temperature elongation ends very soon after load application. Above 550° C. C steels cannot reach a stable condition under a load. At temperatures below 400° C. creep may be high at the beginning, but the elongation soon stops. Above 550° C. initial elongation may be low, but the creep rate remains constant. Intercrystalline fractures can be produced only after a long treatment and they occur without any previous signs of danger. Fractures produced by slipping of crystals caused by long application of load are not accompanied by localized reduction of area. The conclusions were reached at the Laboratoire Federal d'Essai des Materiaux by using Amsler machines provided with a heating arrangement. Fatigue consists of the reduction of the molecular cohesion of the metal and it proceeds from a center of perturbation located in the space lattice. This center can be determined in any fatigue fracture by a finer grain size as compared with the rest. Fatigue fractures are neither severance fractures nor fractures caused by slipping along slip planes. At room temperature fatigue action is the most pronounced when the oscillations are of the same magnitude but of an opposite sign. Comparative distortability defining permanent deformation is constant for every given temperature and is equal to the normal resistance to oscillatory tension and compression. In cases of alternating loads plastic deformation caused by slipping along slip planes does not exert a favourable effect. A load applied in one direction increases the resistance of metal to stresses so that an equal load but of an opposite sign does not restore the original dimensions. In torsion testing alternating loads increasing from zero to a maximum are less destructive than the loads of the same maxima but having alternately opposite signs. At high temperatures the resistance to loads oscillating to maxima of opposite signs increases with the temperature. High temperatures reduce the perturbations in the space lattice and eliminate the nuclei of perturbations from which the fatigue failures start. JDG (12)

Fatigue Limit and Notch Sensitivity of Steels at High Temperatures (Wechselfestigkeit und Kerbempfindlichkeit der Stähle bei hohen Temperaturen). W. Schwinning, M. Knoch & K. Uhlemann. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Dec. 22, 1934, pages 1469-1476. 10 kinds of steel with from 43 to 117 kg./mm.^{2} tensile strength were examined with regard to static properties, endurance strength under alternating bending and the influence of notches on the latter at temperatures up to 500° C. The elastic limit decreased in all the steels much more than endurance strength; the latter increased even in unalloyed steels at 300°-400° At 300° the endurance strength of unalloyed and weakly alloyed steels exceeds the elastic limit so that in such cases it must be decided which type of loading is controlling for the selection of the admissible stress. Notch effects do not reduce elastic limit in plastic materials as the stresses are equalized by plastic deformities; the endurance strength, however, is reduced, and particularly in steels of high resistance where a notch of even very little depth (scratch) brings about a considerable reduction. At 500° C., all steels already show such structural changes that no general rules can be given any more for their behavior. Numerous curves illustrate the described changes in properties. Ha (12)

Influence of the Type of Structure Upon the Creep Strength of Steel (Einfluss der Gefügeausbildung auf die Dauerstandsfestigkeit des Stahls). W. Enders. *Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung, Düsseldorf,* Vol. 16, No. 14, 1934, pages 159-167. The influence of the grain structure on the time-elongation curves of plain and alloy steels, normally annealed and overheated (coarse grain), was investigated. The coarse-grained state showed in all steels the highest creep strength; cast structure and overheated structure have the same effect. Refining did not bring about an improvement of the creep strength at 500° C.; a refined Cr steel and a 0.4% C steel showed a considerably reduced creep strength. Spheroidized cementite had a lower creep strength than laminar pearlite; cementite precipitated at the grain boundaries had practically no effect. Comparison of the influence of heat-treatment of different steels on tensile strength at room temperature with the influence on creep strength at 500° C. showed that the change in creep strength and in tensile strength are in the same direction, but that differences in structure have a far greater effect on creep strength than on tensile strength. Curves and micrographs illustrate the results. 12 references. Ha (12)

Apparatus for High Temperature Testing and Flow Strength of Some Steels (Appareillage pour les essais à haute température et résistance a l'écoulement de quelques aciers). I. Musatti & A. Reggiori. *Revue de Métallurgie,* Vol. 31, Oct. 1934, pages 421-438. Furnace with a condensed winding and direct loading were used. Temperature was kept within 3° C. over the length of the tube furnace by a dilatation regulator (fully described). Elongation was measured with Martens apparatus as modified by National Physical Laboratory. A battery of these furnaces was kept in a constant temperature room. A 100-hour cycle at 500°, 600°, 700° and 800° C. was applied to 6 high alloy steels. Curves were plotted using 0.001%/hour and 0.0001%/hour elongation and loads producing total elongation of 0.1% in 100 hours as a basis. Cr-Ni austenitic steels had the best flow characteristics, Cr-Si, Cr-Co-Mo and high speed steels were inferior to the former. JDG (12)

Belgian Research Committee on the Behavior of Metals at Elevated Temperatures. H. Dustin. *Enginering,* Vol. 138, Oct. 5, 1934, pages 367-369. From paper read before the Iron & Steel Institute, Brussels, Sept. 1934. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 584. . LFM (12)

The Creep Strength of Steels as Affected by Alloy Content and Heat Treatment (Die Dauerstandfestigkeit von Stählen in Abhängigkeit von Legierung und Wärmebehandlung). P- Grün. *Archiv für das Eisenhüttenwesen,* Vol. 8, Nov. 1934, pages 205-211; *Mitteilungen aus dem Forschungs-Institut der Vereinigten Stahlwerke Aktiengesellschaft,* Dortmund, Vol. 4, July 1934, pages 113-160. The tensile, yield, and creep strengths (short time tests) were determined for a series of low alloy steels at 400 and 500° C. In the short time creep tests the creep strength was taken as the load at which the rate of creep was 5 x 10^{-4}%/hr. between the 25th and 35th hr. of the test, this being considered as a workable criterion. At 400° C. the tensile and yield strength increased considerably with C and Cr, whereas the creep strength increased much less, and even fell somewhat at contents above 0.3% C and 1% Cr. Similar addition of Si, Mn, and Cu compared very favorably on a cost basis in raising the creep strength at 400° C.; at 500° C. Mo gave the most favorable results. At 500° C. raising the C was practically without effect. W and V, which do very well in raising the creep strength at 400° C., fell behind Mo at 500° C. Adding several elements seems better than adding a similar total amount of one element. In C, Mn, Cr, and Cu steels. the pearlitic structure obtained on slow cooling gave the best creep strength. After heat treatment the creep strength was lower, probably because of the more ready coalescence of the cementite. Mo and V steels also showed the best creep strength after air cooling. Long time creep tests up to 1000 hrs. showed that the time-extension curves were not parabolic for all steels. SE + Ha (12)

Creep Testing and High Creep Steel. Francis B. Foley. *Iron Age,* Vol. 132, Dec. 21, 1933, pages 21-23. Abstract of paper read before the New York chapter of the American Society for Steel Treating. Divides steels into 3 classes for high temperature use. To the first class belong the pearlitic steels used up to 850° to 900° F.; to the second class, medium and high alloy pearlitic and low alloy austenitic steels used up to about 1250° F.; and to the third class, the high alloy pearlitic and austenitic alloys used at the higher temperatures. Addition of small amounts of alloying elements increases the resistance of C steel to creep. Addition of alloy requires close study to guard against production of temporary high creep properties in relatively short time tests. Gives procedure in testing. VSP (12)

Siberian Rail Fractures at Low Temperatures. B. M. Suslov. *Iron Age,* Vol. 133, Feb. 1, 1934, pages 18-20. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 544. VSP (12)

Methods of Testing Steel at Elevated Temperatures (Considérations sur les méthodes d'essai des aciers à haute température). H. Dustin. *Revue de Metallurgie,* Vol. 31, Sept. 1934, pages 409-420. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 538. JDG (12)

Effect of Temperature Upon the Reflectivity of Copper, Silver and Gold. Yoshio Fujioka & Tatsuro Wada. *Scientific Papers of the Institute of Physical & Chemical Research, Tokyo,* Vol. 25, Oct. 1934, pages 9-19. In English. The relative reflectivities of Ag, Cu, and Au are experimentally determined at 0°, 100° and —180° C. (liquid O_2) for the wave lengths from 2500-6500 A.U. On the basis of the dispersion theory, the reflectivity of Ag is calculated for 0°, 100° and —180° C. taking into account thermal expansion and damping factors. The agreement between theoretical evaluation and experimental determination is satisfactory on essential points. WH (12)

The Thermal Expansion of Silver, Quartz and Bismuth by X-ray Measurements. A. H. Jay. *Zeitschrift für Kristallographie,* Vol. 89, Sonderheft "Ideal- & Realkristall," Oct. 1934, pages 282-285. In English. Difference between optical and X-ray determination of thermal expansion coefficients of Bi as reported by Goetz & Hergenrother *(Physical Review,* Vol. 40, 1932, page 137, page 643) could not be confirmed. Identical coefficients were also found in the case of Ag and SiO_2. When one deals with single crystals it is reasonable to expect an agreement between the behavior of the lattice and that of a crystal block. On the other hand where the substance is an aggregate of crystal grains one can conceive of a small difference arising from the grain boundaries. A large number of X-ray observations were made with Bi powder between 18.5° and 268° C. A sudden expansion between 70° and 80° C. is regarded as evidence of an allotropic change as suggested by Ho from optical measurements. Above 250° C. the curve falls well below that corresponding to a continued linear expansion. EF (12)

Study Needed on Metals for High Temperature Service. H. L. Maxwell. *Steel,* Vol. 94, May 14, 1934, page 46. Abstract of a paper before the Pennsylvania interchapter meeting of the American Society for Metals in State College, Pa., May 4-5, 1934. Although progress has been made during the past 5 years in the development of ferrous alloys to resist high-temperature, high-pressure conditions in hydrogenation processes and high-pressure syntheses, especially NH_3 synthesis, there is need for further and intensive research in this field. MS (12)

Influence of Grain-Size on the High Temperature Characteristics of Ferrous and Nonferrous Alloys. A. E. White & C. L. Clark. *Transactions American Society for Metals,* Vol. 22, Dec. 1934, pages 1069-1098. Paper read and discussed at Grain-Size Symposium, A.S.M. Convention 1934 and previously abstracted from Preprint 15, 1934. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 538. WLC (12)

An X-Ray Study of the Effect of Heat on the Structure of Sputtered Films of Gold. S. Rama Swamy. *Proceedings Physical Society, London,* Vol. 46, Nov. 1934, pages 739-744. On heating sputtered gold films up to 800° C., the crystals orient themselves with their 111 planes parallel to the surface, and crystal growth takes place, to a degree depending on the thickness of the film and the temperature of heating. JCC (12)

13. CORROSION AND WEAR

V. V. KENDALL, SECTION EDITOR

Field Tests on Corrosion. J. C. HUDSON. *Metal Industry,* London, Vol. 44, Apr. 20, 1934, pages 415-418; Apr. 27, 1934, pages 441-443. A paper read before the Midland Metallurgical Societies, Mar. 1, 1934. Brief account of research work abroad with a description of work in progress in England. In Germany, work under the direction of O. Bauer, using mild steel to which Cu was added in the molds is discussed. The conclusion drawn by Bauer and his associates is that, in general, atmospheric corrosion of steel in open air is reduced by increasing Cu content and that most marked difference lies between Cu-free steels and those containing 0.20% Cu. This agrees with conclusions from America. In the United States, the most important tests are those of the A.S.T.M. Committee A-5 and B-3. Results show addition of Cu is advantageous in reducing atmospheric corrosion. Kendall and Taylerson concluded that in the Pittsburgh tests while Cu was beneficial, the longest life was obtained with high Cu combined with P. Another series conducted by Committee A-5 is work on galvanized sheets and various protective coatings in progress at State College, Pa. Various types of protective coatings have been applied to 27 different kinds of hardware and exposed. The conclusion drawn, as far as zinc coatings are concerned, is that resistance to corrosion depends essentially upon their weight. A min. wt. of 2 oz. should be specified for reasonable long life from unprotected galvanized sheet. This is in agreement with the author's work for the British N.F.M.R.A. In Sweden, the work of Dr. Gregor to ascertain effect of atmospheric corrosion on various types of very low carbon steels that might be suitable for telegraphic wire is discussed. Those that contained Cu were most resistant to corrosion. In Holland, corrosion work was started in 1931 on pipe lines, cables and structural steelwork. So far, in the work on cables, the attack on lead sheathing that has been investigated is attributed to presence of tar acids on the outer wrappings. The methods used by the author in his work on corrosion are (1) measurement of gain in weight, of specimens, (2) the loss in weight of specimens, (3) the increase in electrical resistance of wire specimens, and (4) the decrease in breaking load applied to wire specimens. In addition to the quantitative amount of Cu, the effect of surface condition which includes mill scale is being studied. Other work being conducted by the committee is done on specimens painted either with red lead and then red oxide or with only red oxide. These are applied to several types of surface conditions and should yield valuable results. It is planned to extend the work to include marine corrosion. In view of the large number of varied investigations being now carried on, the author is quite optimistic that considerable development will result within the next decade or so. HBG (13)

Maintenance and Protection of Cast Iron Water Pipes. With Special Reference to Economic Factors. FRANK WILLIAM FOSTER WAITT. *Journal & Transactions Institute of Engineers of Australia,* Vol. 6. Sept. 1934, pages 293-302. The paper deals with some of the economic problems met with in the design and operation of a water supply system. The high cost of providing and maintaining cast Fe mains in the 3500 mile Sidney distribution system had led to the use of other materials, notably cement lined steel, bitumen lined steel, wood-stave and fibro-cement pipes. Lining of pipes with cement mortar (1 cement : 1½ sand) before laying has become the standard practice in Sydney resulting in savings of several thousand £/annum. According to American investigations, soft waters cause considerable leaching out of the Ca-salts in mortar. However, perished cement coatings may still give an effective protection against rust for many years if undisturbed due to the formation of a protective layer of Fe hydroxide. Inspection after 6 years service disclosed that the cement surface had deteriorated from 1/16-1/8 in. and that it could be scraped off by hand with a chisel. However, below this the mortar lining was hard and dry. Analysis showed that the outer portion had lost a large portion of its lime content. A cold application of bituminous emulsions to the interior of the cement lining is now made for Sydney pipes so as to give a sealing coat and to aid curing. WH (13)

Electro-Motive Series of Bases and Acids (Ueber eine Spannungsreihe der Säuren und Basen). EGON WIBERG. *Zeitschrift für physikalische Chemie,* Abt. A, Vol. 171, Nov. 1934, pages 1-24. Acidity potentials are introduced as a measure of acidity and basicity and an electro-motive series of acids and bases is set forth. EF (13)

Study on the Passivity of Iron and Steel in Nitric Acid Solution. Report III. YOICHI YAMAMOTO. *Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, Dec. 1934, pages 1446-1500. In Japanese. *Abstracts of the Bulletin Institute of Physical & Chemical Research, Tokyo,* Vol. 13, Dec. 1934, page 85. In English. The effect of urea additions to concentrated HNO_3 was studied in relationship to the appearance of the passivity of soft steel and cast Fe. Due to the ability of urea to remove nitrous acid the passivity phenomenon was absent. It is concluded that nitrous acid acts as the oxygen carrier to the surface of the metal and that the presence of nitrous acid accelerates the appearance of the passivity of Fe. This took place instantaneously in HNO_3 but was eliminated in a few minutes by urea additions. It was also found that "so-called HNO_3 resisting stainless steels" are corroded severely in HNO_3 containing some urea. WH (13)

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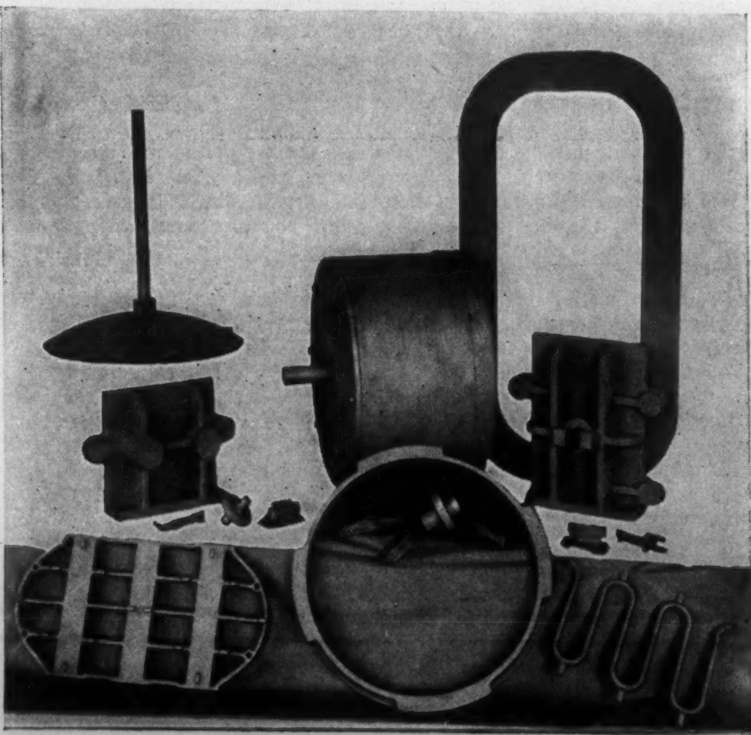

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Corrosion of Ship Hulls by Low Maritime Animals (Korrosion der Schiffshaut durch niedere Seetiere). C. Bärenfänger. *Die Umschau in Wissenschaft & Technik,* Vol. 38, Sept. 2, 1934, pages 711-712. Barnacles settling on ship hulls reduce the ship speed up to 18% and increase the coal consumption up to 29%. Antifoulings did not turn out 100% successful. A lacquer coating does not prevent settling but blocks the perforation of the paint coating which is indispensable for rust protection. Ships can thus be scraped in order to remove the barnacles but without imperiling the rust inhibiting action of the coating. WH (13)

Metal Sprayed Surfaces Pass Acid Test. R. A. Axline. *The Metallizer,* Vol. 3, Sept. 30, 1934, pages 7, 12. Corrosion tests were made over a period of 220 days on monel metal, cadmium, lead and phosphor bronze coated steel paper pulp wash pans subjected to hot alkaline liquors, (NaOH), vapor, gases and moisture from the cooking of wood. Monel metal gave best results with a 0.03″ coating giving an indicated corrosion rate of 0.000128″ per year. Cadmium corroded at double this rate and lead 10 times as fast although still showing an estimated 10 year life for a 0.025″ coating. Phosphor bronze corroded badly during the test. Total cost of metallizing was estimated at \$2.10/ft.^{2} for 0.03″ monel metal, \$0.77 for 0.010″ Cd, \$0.38 for 0.025″ Pb. BWG (13)

Passage of Hydrogen Through Steel. C. A. Edwards. *Nature,* Vol. 133, Mar. 10, 1934, page 379. Cites several studies of hydrogen diffusion in steel during corrosion experiments. CSB (13)

Texture and Chemical Resistance of Metals. C. H. Desch. *Iron & Coal Trades Review,* Vol. 129, Nov. 2, 1934, pages 673-674; Nov. 9, 1934, pages 726-727. The degree of resistance to chemical attack of a metal depends essentially on chemical composition and distribution of the chemical components into distinct constituents or phases. The arrangement of these constituents can be described as "texture"; it is determined and made visible by the use of microscope, X-rays and spectroscope. When an alloy consists of 2 phases of different chemical composition they will also differ in electrolytic potential, so that at every contact between them a local couple will be set up thus facilitating chemical action; such alloys are more rapidly etched than one-phase alloys. The effect of tempering at low temperature, precipitation, stabilizers and additions of Cu to steel on the formation of local elements and consequent change of chemical resistance is discussed more fully. Oxidation proceeds quite evenly over the metallic surface independently of the grain boundaries. Intercrystalline oxidation only occurs when the metal is under tensile stress. Ha (13)

Gas Company Manager Inspects Pipe on Ocean Floor. *Natural Gas,* Vol. 15, July 1934, page 15 and 26. Describes the repair work done on an 8″ transmission line lying along the bottom of the bay between the mainland and Galveston island. The Fe pipes damaged by corrosion and electrolysis were hoisted above the water and repaired by cutting and welding. WH (13)

Test of Zinc Metallized Steel in Canada Proves Superiority. *The Metallizer,* Vol. 3, Oct. 31, 1934, page 9. Results are given by Canadian Inspection and Testing Co. of corrosion tests on zinc sprayed, galvanized and cadmium coated steel samples. The test pieces were subjected to a strong salt spray for an hour, allowed to stand in a salt spray atmosphere for seven hours, allowed to dry over night, washed and the cycle repeated daily. In 10 days the galvanized sample began to show rust, the other samples only gray streaks. A 0.003″ metallized zinc sample began to show rust in 45 days; a single cadmium coat lasted 64 days; 0.006″ metallized zinc lasted 75 days. At the end of 90 days both the double coated cadmium and 0.009″ metallized zinc sheets were in good condition. Bond of sprayed zinc with steel sheet is illustrated by two photomicrographs. BWG (13)

Wear Resisting Materials and Coke Handling Equipment. *American Gas Journal,* Vol. 140, June 1934, pages 31-32. Chief application of abrasion resisting material lies in its use in crushing equipment, screens, chutes, and other parts of the plant which are subjected to abrasive action of moving coke. Materials used include hard cast iron, Ni-Cr irons, Mn steels, Stellite, Stoodite and tungsten carbide applications, brick, tile, and rubber. Coke chutes and coke screen designs are discussed. CBJ (13)

Does Pressure Favor Rusting of Iron? (Begünstigt Druck das Rosten von Eisen?). A. Bender. *Korrosion & Metallschutz,* Vol. 10, Oct. 1934, pages 235-241. Although some observations seemed to lead to the conclusion that iron pipes in hydraulic and power stations had a tendency to rust particularly in places where the material was under pressure or had internal stresses due to notch effects originating by manufacturing processes, a closer investigation did not give positive evidence of the correctness of this view. Quality of water, scale of rolling, notches, or even invisible lesions on the surface of the material exert a much stronger influence. Ha (13)

Water Problems in the Cape Breton Coal Mining Districts. J. L. Bowlby. *Transactions, Canadian Institute of Mining & Metallurgy,* 1934 (in *Canadian Mining & Metallurgical Bulletin* No. 270, October) pages 491-512. The mechanism of various types of corrosion are reviewed. 0 corrosion can be controlled by maintaining higher alkalinities in the boiler than ordinarily maintained because of fear of caustic embrittlement. The solution tension theory of Nernst is used to explain the characteristics peculiar to corrosion-resisting alloys. AHE (13)

Corrosion from Products of Combustion of Gas. C. V. Bennett. *Iron & Coal Trades Review,* Vol. 129, Nov. 9, 1934, page 724. The investigation examines the action of products of combustion of coal gas upon various materials used in the construction of gas appliances. The loss of weight of tubes of Pb, Al, Cr plate, Ni plate, brass (70/30), Cu of various hardness, black and galvanized Fe, and Zn was determined after 1 month of gas passing through the tube. The present practice of using Pb, Sn and solder for protective coatings was found justified provided that a sufficiently thick and uniformly adherent coating is obtained. Zn, black and galvanized Fe are unsuitable where contact with acid condensates are likely to occur. The tests with Cr plate and Ni plate did not yield any conclusive results. Ha (13)

Corrosion Problems in Iron and Steel. Frank N. Speller. *Iron Age,* Vol. 133, June 14, 1934, pages 28-31, 68. See *Metals & Alloys,* Vol. 5, Sept. 1934, page MA 463. VSP (13)

Recent Tests on Duralplat (Neuere Versuche mit Duralplat). K. L. Meissner. *Werft, Reederei & Hafen,* Vol. 15, May 1, 1934, pages 107-108. See *Metals & Alloys,* Vol. 5, June 1934, page MA 292. WH (13)

Electrolytic Disintegration of Direct-Current Railroad Feeders (Elektrolytische Zersetzung von Gleichstrom-Bahnspeisekabeln). W. Wegener. *Korrosion & Metallschutz,* Vol. 10, Sept. 1934, pages 213-217. The case of a railroad feeder cable is reported where the lead sheath was destroyed by electrolytic corrosion due to potential differences occurring between sheath and water pipes and rails. Isolation of the sheath electrically where it can become anode in order to obviate corrosion is recommended. Instruments which indicate faulty conditions are suggested. Ha (13)

Canadian Demonstration Proves that Corrosion of Steel Bridges Can Be Stopped. R. J. McWaters. *Metallizer,* Vol. 3, Sept. 30, 1934, pages 4-6. Metal spraying of steel bridges with zinc is recommended from results of metallizing a bridge for the Canadian National Railways. Coatings of 2 oz. Zn/ft.^{2} were given uprights and a 6 oz. coating to the steel subjected to brine corrosion from refrigerator car drippings. Operating difficulties are described and advantages of metallizing cited. Actual cost of metallizing alone was less than \$0.10/sq. ft. but it is thought that this could be reduced to \$0.065/sq. ft. exclusive of sand blasting, compressed air, scaffolding and set up. BWG (13)

Metallurgical Aspect of Coal Hydrogenation. Effect of Hydrogen on Converters. A. T. Barber & A. H. Taylor. *Iron & Coal Trades Review,* Vol. 129, Nov. 23, 1934, pages 806-807. Difficulties in the operation of converters for the hydrogenation of coal and tar for the production of motor spirit under high pressures are reported and discussed; pressures up to 6000 lbs./in.^{2}, and temperatures up to 950° F. were applied. Mild steel was completely destroyed by H, special alloys were less liable to destruction, but the most satisfactory service could be obtained by insulating the pressure resisting walls from the heating medium so as to avoid the metal being heated above 200° F. Ni-Cr and Cr-Mo steels absorbed H at high temperature so that in time the lattice cohesion was broken and cracks formed. Ha (13)

Blistering of Iron Oxide Scales and the Conditions for the Formation of Non-Adhering Scale. R. Griffiths. *Iron & Coal Trades Review,* Vol. 129, Oct. 5, 1934, pages 498-499; *Heat Treating & Forging,* Vol. 20, Sept. 1934, pages 447-450; *Engineering,* Vol. 138, Oct. 19, 1934, pages 427-428. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 586. Ha+LFM+MS (13)

An Interesting Special Case of Application of Silumin (Ueber einen interessanten Sonderfall der Verwendungsmöglichkeit von Silumin). G. Eckert. *Aluminium,* Vol. 17, Sept. 1934, pages 31-34. Corrosion observed in pure Al vessels for boiling linseed oil and varnishes was traced to overheating the oil; strict temperature control can prevent the corrosion but local overheating can be made harmless by use of silumin instead of pure Al. Silumin, cast or in rolled sheets, is entirely resistant against high-molecular fatty acids, boiling aniline and butyl alcohol. Ha (13)

Topo-Chemical Viewpoints in Metal Corrosion (Topochemische Gesichtspunkte der Metallkorrosion). Ulick R. Evans. *Kolloid Zeitschrift,* Vol. 68, Aug. 1934, pages 133-137. The progress of the corrosion attack is decisively influenced by topo-chemical and geometric factors. When an insoluble product is precipitated in direct contact with the metal, the corrosion attack usually slows down. This is not the case if the precipitation takes place at a distance from the metallic surface. This phenomenon explains why a few water drops condensed on Fe produce corrosion and rusting whereas others only cause slight discoloration. The probability of corrosion depends greatly on the surface contour and is most pronounced at projecting points. Corrosion is reduced by preceding exposure to 0 due to the formation of an invisible protective oxide film but is increased with falling 0 concentrations in the atmosphere surrounding the drop. Reaction velocities are larger with higher 0 concentrations than with lower ones. If rust coming from a corrosion pit is carried to other spots of the metallic surface, the access of 0 may be inhibited which increases the probability of corrosion. If a protective rust layer is absent, the change of potential occurring at the beginning of the corrosion attack always tends to decrease the possibility of a corrosion attack of the adjacent regions. EF (13)

Influence of Methods of Immersion of Samples in Experiments on Corrosion (Étude de l'Influence du Mode d'Immersion des Éprouvettes dans les Essais de Corrosion). Jean Cournot & Marcel Chaussain. *Comptes Rendus,* Vol. 199, Dec. 10, 1934, pages 1410-1411. Samples were 50 x 45 x 1 mm. suspended vertically in salt water. The method of treatment was as follows: 1. Samples were immersed and withdrawn alternately. 2. Samples were immersed 5 mm. below surface of liquid and slow evaporation allowed to take place over a period of 20 days to lower the liquid to a level 5 mm. above the bottom of the sample. 3. Samples were immersed just below the surface of the liquid and more liquid was added to prevent any lowering of this level. 4. Samples were immersed 500 mm. deep in the liquid. Loss of weight in gms. as given below for these tests is an average of 2 experiments:

	1	2	3	4
Pure Al	0.054	0.120	0.089	0.074
Duralumin	0.129	0.299	0.151	0.105
Armco Fe	4.317	0.457	0.230	0.165
Ordinary Steel	5.149	0.553	0.267	0.197

These results show that Al and Mg alloys can best be studied by progressively decreasing the level of the liquid used for immersion. FHC (13)

Prevention of Corrosion in Power Station Plant. *Commonwealth Engineer,* Vol. 22, Sept. 1, 1934, pages 43-49. Discusses in a qualitative rather than quantitative manner the corrosion in condenser tubes (and erosion, dezincification, pit holing), feed lines, economiser tubes, boiler tubes and drums, superheater tubes, ferrous turbine blades and turbine casings, and steam fittings. Particular attention is given to boiler corrosion and various methods effective as preventives or palliatives are mentioned. WH (13)

Boiler Diseases. The Why and How of Conditioning Boiler Feed Water Told in Simple Fashion. T. E. Purcell & D. S. McKinney. *Electric Light & Power*, Vol. 12, May 1934, pages 23-26; June 1934, pages 45-54. Embrittlement ratio of Na_2SO_4: Na_2CO_3 alkalinity given, also other chemical equations for corrosion control and corrosion constant evaluated in terms of composition of feed water. Dissolved salts as a cause of scale, foaming and burning of boiler and tubes. Deaerating principles and practice given as used in power station of Duquesne Light Company. WB (13)

Heat Resistant Alloys and Their Utilization in Ceramic Industry (Hitzebeständige Metalle und ihre Verwendung in der keramischen Industrie). Schirm. *Keramische Rundschau, Kunstkeramik, Feinkeramik, Glas, Email*, Vol. 42, Mar. 1, 1934, pages 106-108; Mar. 8, 1934, pages 119-121; Mar. 15, 1934, pages 132-134. Sufficient strength, resistance to scaling and resistance to temperature changes are the main requirements to be met with by heat resistant materials among which Cr-Ni, Cr-Ni-Fe, Cr-Fe, Al-Fe, Cr-Ni-Al-Fe and FeC alloys are considered. The danger of warping and scaling of heat resistant alloys with reference to some typical examples in ceramie industry is pointed out. Alloys specially suited for some peculiar applications are still lacking. Cases are critically discussed where ordinary materials can be utilized advantageously if an adequate design of the member exposed to severe heat stresses is made. SiC in lieu of chamotte is sometimes preferable due to its superior heat conductive properties, strength and gas permeability. EF (13)

Corrosion from Products of Combustion of Gas. Part II. Tube Experiments. Sub-Committee Institution of Gas Engineers. *Gas Engineer*, Vol. 51, Dec. 1934, pages 634-635. Two sets of experiments are described in which a number of metal tubes were simultaneously subjected to the continuous action of combustion products of coal gas for 1 month and 3 weeks respectively. The tubes were water-cooled so that 80-95% of the H_2O from the combustion gases was condensed. This together with the S and N acids dissolved therein formed the corroding medium. The amount of condensate, its concentrations of metal, S and N acids and the total weight of metal lost were determined. The materials investigated fall into 3 main groups exhibiting good, medium and poor resistance to attack. The loss of weight tests (expressed in grams) showed the following results: (A) Pb = 0.15, Sn = 0.02, solder = 0.06. (B) Al = 0.59, Cr plate = 1.97, Ni plate = 3.44, brass (70/30) = 3.27, Cu, hard = 4.20, Cu, soft = 4.49. (C) Fe, black = 8.75, Zn = 9.16. A new set of fresh metal samples yielded worse results for group (C) than given above. The sequence of metals was not materially altered when the S content of the gas was raised from 25 to 50 g./100 $ft.^3$ by the introduction of carbon bisulphide. The present practice of using Pb. Sn and solder for protective coatings is justified. but attention should be directed to the technique of applying such coatings in a sound and adherent condition and of greater thickness and uniformity than is mostly the case. Zn, black Fe and galvanized Fe are clearly quite unsuitable materials for use where contact with acid condensates is likely to occur. The experiments on Cr and Ni plate are inconclusive. (Part I See *Metals & Alloys*, Vol. 5, June 1934, page MA 293 L 6.) WH (13)

Underground Systems Round Table. *Electric Light & Power*, Vol. 12, Nov. 1934, pages 8-10. For high voltage cable in operation in 1933 the failure rate was 5.0 per 100 miles or 3.1% less than in 1932. Increase in failures in tests results in lower line failures. The percentage of cable failures for which a cause was defineable has been increased to 88%. One company noted that an increase in corrosion took place on cables when the street railway took up its tracks and discontinued operation. WB (13)

Welding Corroded Rivet Heads. *Railway Engineering & Maintenance*, Vol. 30, Oct. 1934, pages 539-541. When 150,000 rivets in a large steel viaduct became so badly corroded as to require renewal, the P.R.R. decided to build them up by welding with the electric arc. As compared with renewing the rivets outright, this method has proved faster and at the same time more economical. 2 welders complete from 275-300 rivets/day. Brine drippings from heavy refrigerator traffic caused many rivet heads to waste away to a fraction of their original size while still remaining tight and functioning perfectly in shear and in bearing. WH (13)

The Corrosion of Iron and Steel. *Engineer*, Vol. 157, June 22, 1934, pages 639-640; *Engineering*, Vol. 137, June 29, 1934, pages 743-744; *Iron & Coal Trades Review*, Vol. 128, June 1, 1934, pages 881-883. Summary of the second report of the Corrosion Committee of the Iron and Steel Industrial Research Council presented June 1, 1934, before the Iron & Steel Institute. See *Metals & Alloys*, Vol. 6, Jan. 1935, page MA 38. Ha + LFM (13)

Evaluation of New Finishes by Accelerated Tests. B. V. McBride. *Electrical Manufacturing*, Vol. 13, Sept. 1934, pages 20-21. The cycles used in accelerated weathering machine are given. It is claimed that the results duplicate very closely those obtained on outdoor test-fence for summer exposure. Humidity cabinet described for effect of humid conditions on finishing materials. WB (13)

Corrosion Phenomena in Hot-Water Tanks (Korrosionserscheinungen an Heisswasserspeichern). R. Scherer. *Bulletin der Schweizerischen elektrotechnischen Vereine*, Vol. 24, 1934, page 517; *Elektrotechnische Zeitschrift*, Vol. 55, Dec. 6, 1934, pages 1208-1209. Carefully hot-galvanized boilers (1000-1200 g. $Zn/m.^2$) after some time showed irregularly distributed spots of corrosion and rusting; investigation seems to ascribe them to electro-chemical processes in which 0 causes local currents according to its distribution on the Zn or Fe surface. CO_2 in the water also attacks Zn which is transformed into soluble Zn carbonate. Chlorides in the water are especially harmful causing anodic corrosion. An instrument is described which permits determining quickly and accurately the condition of the water. Enameled boilers did not give satisfaction, only tinned Cu boilers can be considered as "corrosion proof"; even the most unfavorable water conditions did not lead to corrosion. It is stated that Cu boilers are mechanically absolutely safe and withstand sudden pressures and stresses. Tinned brass vessels, however, did not behave as well as Cu vessels as they became very brittle in time. Ha (13)

Initial Wear. Harry Shaw. *Machinery*, London, Vol. 45, Dec. 20, 1934, pages 427-431. Discusses the influence of surface finish and use of colloidal graphite lubricant. Wear is determined in terms of surface roughness. Less wear occasioned by colloidal graphite in circulating oil. WB (13)

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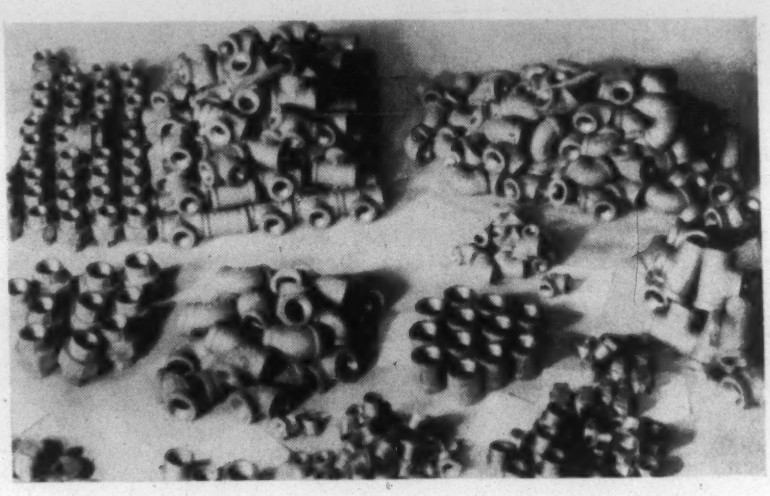

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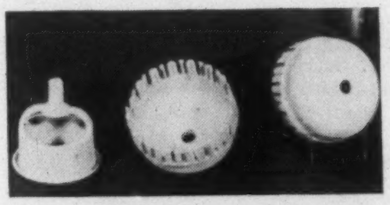

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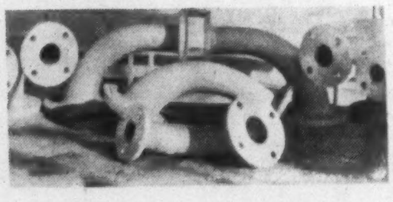

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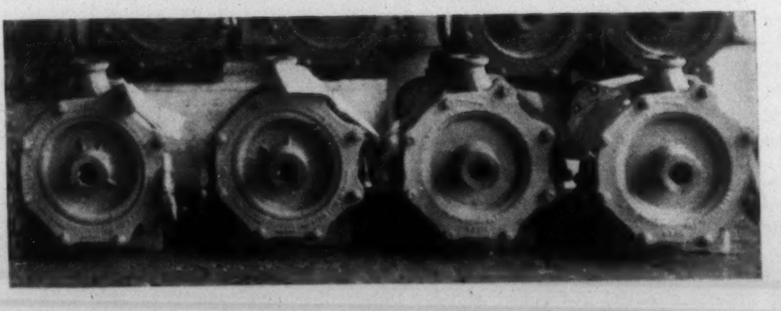

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14. APPLICATION OF METALS AND ALLOYS

Metals and Alloys in the Pulp and Paper Industry. J. D. Miller. *Metals & Alloys,* Vol. 5, Dec. 1934, pages 263-267. Describes various operations in paper making and the effect of operating conditions upon the properties required in materials used in equipment construction. Cr and Cr-Ni alloy steels have aided materially in the solution of corrosion problems with hard surfacing combating abrasion problems. Nitriding and chrome plating are used where conditions allow them to effectively meet corrosion and wear. WLC (14)

Alloys Play Important Part in Furnace Conveyors. M. K. Mellott. *Iron Age,* Vol. 134, Sept. 6, 1934, pages 28-33. Describes some of the more widely used methods of conveying materials through furnaces and the requirements of alloys used in this connection. VSP (14)

Steel Used Decoratively for Interiors Aids Ship Safety. A. H. Jansson. *Steel,* Vol. 95, Sept. 17, 1934, pages 10-12. Replacement of wood and other inflammable material by steel and other metals treated decoratively for interior finishes and similar purposes will greatly reduce fire hazard on board ship. MS (14)

To Compare Merits of Three New Street Car Designs. W. G. Gude. *Steel,* Vol. 95, Oct. 1, 1934, pages 29-30. Describes principal features of 3 street-cars placed in experimental operation by the Chicago Surface Lines. (1) Made of "Cor-Ten" steel, weighs 31,400 lbs., seats 47, and is 45 ft. long. (2) Made of Al, weighs 29,600 lbs., seats 58, and is 50 ft. long. (3) Made of C-V steel, weighs 37,340 lbs. and has same capacity and length as Al car. (1) was assembled by welding. MS (14)

Reaching the Limits in Bearing Performance. H. B. Dexter. *Machine Design,* Vol. 6, Dec. 1934, pages 15-19. Discusses structural features, lubrication, wear and material. Bearing design is fundamentally a lubrication problem. Hardened steel surfaces are always best because they take the best finish and retain it longest. Hardened steel journals and hard cast phosphor bronze will stand much more abuse under boundary or merely greasy lubrication. Rolled soft brass or bronze should never be used for bushings in severe service. Leaded bronze will stand a lot of pounding and more heat than babbitt. Babbitt withstands hammering far better in the old fashioned boxes having some anchorage. Data on maximum safe endurance of bearings, correlating loading, cycle, surface velocity, journal (material, finish) and bearing (material, finish) are tabulated. WH (14)

Metallurgical Applications of Silicon. J. W. Donaldson. *Metallurgia,* Vol. 11, Nov. 1934, pages 20-22. Discusses use of Si in ferrous and non-ferrous alloys. JLG (14)

Powder Metallurgy and Its Applications. *Mining & Metallurgy,* Vol. 15, June 1934, page 256. Powder metallurgy is concerned with mixing of certain metals in powdered form so as to form certain compositions. The mixture is subjected to high pressure and resulting material is heated to fusion point producing a homogeneous metal or alloy product. Much has been written concerning powder metallurgy. The latest and most interesting development has to do with sponge Fe. The best product is obtained from Sweden. Its use in this country has been as a charge in steel making to enrich the raw material. The success and satisfaction are said to exceed expectations. VSP (14)

14a. Non-Ferrous

G. L. CRAIG, SECTION EDITOR

Plumbing in Copper and in Iron From Its Technical and Decorative Aspect (Les Canalisations en Cuivre et en Fer sous leurs Aspect technique et décoratif). H. Devillaire. *Cuivre et Laiton,* Vol. 7, Nov. 15, 1934, pages 503-504. As technical advantage of Cu piping over Fe or also Pb is named particularly the lower friction coefficient for water which means smaller diam. for the same output of water. As the wall thickness of Cu pipe is always thinner than for Fe or Pb a greater economy in price due to reduced weight will often be realized. This is exemplified by comparisons of installations. Besides, Cu piping has a much more ornamental effect. Ha (14a)

Demand for Nickel Continues to Expand. N. B. Pilling. *Mining & Metallurgy,* Vol. 15, May 1934, page 274. Variety of uses for pure Ni continues to widen. In addition to its use in coins by 27 countries, the consumption in radio tube manufacture increased to twice that of 1932. Household field provides an important outlet for monel metal. Outstanding development in this field has been the acceptance of monel metal hot-water tanks, range boilers, storage tanks and hot water electric heaters. A Cu-Ni-Sn bronze of about 8% Ni has recently been developed. Another development is a bearing metal consisting of Cd hardened by addition of 2% Ni. VSP (14a)

Cadmium-Base Bearing Metals. Allan S. Gill. *Commonwealth Engineer,* Vol. 22, Oct. 1, 1934, pages 81-84. Paper before the Australasian Institute of Mining & Metallurgy, Aug. 1934, reports on experiments aimed at developing new uses for Cd, an important by-product of the electrolytic Zn process in Australia. A Cd bearing alloy with 3.1% Cu was found to be equal to the best P-bronze bushings and to withstand 2500 lbs./in.^{2} as compared with 1500 lbs./in.^{2} for ordinary white metal bearing alloys. The tendency towards oxidation during melting and casting could be checked by as little as .05% Mg, whereas 0.2% Mg was finally adopted. Mg goes into solid solution and does not affect the microstructure. WH (14a)

Light Alloys for Aeronautical Purposes with Special Reference to Magnesium. Leslie Aitchison. *Journal Royal Aeronautical Society,* Vol. 38, May 1934, pages 382-400. Discussion pages 401-412. Lecture before the R.A.S. discusses in detail Mg alloys for aeronautical purposes. Data are presented in 26 tables giving the physical properties of Mg, Al, Cu, typical Al and Mg alloys in the cast, rolled, extruded, forged, extruded plus heat treated state, effect of Zn, Cd, Al, Mn, Si, Al + Zn, Al + Cd on Mg and effect of Mg on the mechanical properties of Al (wrought and annealed), strength at elevated temperatures, fatigue limits, specific gravity determinations. Further test results refer to corrosion resistance (loss of strength) of a variously treated Mg alloy and different Mg and Al alloys exposed to seawater spray for 0-200 days. The alloys of Al which contain appreciable proportions of Mg, but are free from other elements, resist corrosion more satisfactorily than any other Al-base alloy. Alloys of the duralumin type which have received but a single heat treatment and have been aged at room temperature are the next most resistant to attack. The alloys aged between 100° and 200°C. are inferior in their resistance and are the least resistant of all the alloys. Amongst the plain Al-Mg alloys containing more than 5% Mg, there is no noticeable difference in the resistance to corrosion. Attention is focussed on welding and corrosion resistance of Mg and the utilization possibilities of Mg alloys in airplane construction are listed. The discussion brought out, that Mg propeller blades cannot compete with Al in high speed motors. Surface treatment processes successfully checked corrosion attack on alloys called unstable by the speaker. The limit of proportionality is rather low in wrought and cast Mg alloys. The low capacity for deformation at normal temperatures is a serious disability of Mg alloys. No satisfactory alloy for cold working (rivets) is available at present. Notch sensitivities are: Mg alloy = 9, heat treated duralumin = 0, yellow brass = 0, structural steel = 21. Mg alloys are particularly suitable for parts working at high speeds and have the advantage of low modulus of elasticity and a high fatigue value and excellent machining properties. The difficulties caused by H_2O in tetraethyl-lead-doped fuels are overcome by putting a bag with KF into the Mg fuel tank. A higher % of the orthodox test bar strengths was obtained with Mg castings than with Al ones. The low strength of Mg alloys at elevated temperatures is pointed out. Al and Mg alloys can be used successfully as bearings, provided that they are running against very hard (case hardened) steel shafts. See also *Metals & Alloys,* Vol. 5, May 1934, page MA 234. WH (14a)

Use of Calcium Babbitt for Merchant Mill Bearings. P. Aleksandrov & M. Igonkin. *Stal,* Vol. 4, June 1934, pages 11-21. In Russian. Pb base bearing metals containing 0.75-1.10% Ca, 0.70-1.00% Na, and $<$ 0.5% Sb lasted longer and showed less power consumption than babbitt with a Sn base. The alloy should be protected from oxidation while melting and should be cast at 550°-80°. HWR (14a)

Aluminium in Electric Industry (Aluminium in der Elektrotechnik). H. Schmitt & L. Lux. *Aluminium,* Vol. 17, Sept. 1934, pages 5-15. The great importance and many applications of Al in the electrical industries are reviewed and products and their mechanical and physical properties described. Conditions in the German industry are considered. Ha (14a)

Bearing Analysis Determines Permissible Speeds. William A. Rowe. *Machine Design,* Vol. 7, Jan. 1935, pages 30-32. The following 3 bearing alloys were studied at speeds of 19, 20, 30 and 40 ft./sec. to ascertain their relative characteristics and advantages: (1) 75.7 Pb, 11.6 Sn, 12.2 Sb, 0.5 Cu; (2) 50 Pb, 38 Sn, 11.5 Sb, 0.5 Cu and (3) 89.5 Sn, 7.5 Sb, 3.0 Cu. The test results are presented in diagrams in which temperature has been plotted against the product P x V (P = unit pressure/in.^{2} and V = velocity of journal surface in ft./sec.) proving that the high Pb-base alloy has certain advantages at lower velocities, viz. below 20 ft./sec. In the case of the 50% Pb alloy, the results are very good up to 30 ft./sec. beyond which there is a tendency for a more rapid rise in temperature as the velocity increases. The babbitt metal shows no advantages at low speeds but improves at velocities in excess of 30 ft./sec. In a further diagram points are plotted against both V and P for a constant temperature rise of 70°F. above the ambient temperature. On the performance curves have been superimposed curves of $P \times V^2$ in amounts which fit closely the test results. For a 70°F. temperature rise the following values for C ($= P \times V^2$) are obtained with reference to the 3 bearing alloys investigated (1) 9,000, (2) 24,000 and 22,000 at higher and lower velocities respectively, and (3) 18,000. The elimination of the expensive Sn-base babbitt metal in all applications with the rare exceptions of instances where the velocity exceeds 30 ft./sec. is emphasized. WH (14a)

The Use of Cadmium to Simplify the Making of Dental Crowns. Jos. C. Polenaar. *British Journal of Dental Science,* Vol. 79, Sept. 1934, pages 258-264. Translated from *Tydschrift voor Tandheelkunde,* Jan. 1934. JCC (14a)

The Clean-Up of Various Gases by Magnesium, Calcium and Barium. A. L. Reimann. *London, Edinburgh & Dublin Philosophical Magazine & Journal of Science,* Vol. 18, Dec. 1934, pages 1117-1132. Electropositive metals (Na, Mg, Ca, Ba) absorb (clean up) under certain conditions various gases to which they are exposed; the use of such metals ("getters") may greatly reduce, therefore, the residual gas pressure in vacuum vessels. These conditions were more closely investigated for N and H. In general, it was found that speed and capacity in contact "gettering" of a given gas increase in the order: Mg, Ca, bright Ba, black Ba, and that the getter takes up much more gas than would cover its apparent surface with a monomolecular layer before showing signs of "fatigue"; the gas may either combine chemically with the getting material or be adsorbed on its surface, and adsorption is followed by diffusion into the interior of the getter deposit. If the gas does not form a chemical compound it can be liberated again later. Electric discharges may change the character of the "gettering" by producing a stable chemical compound which would not form by mere contact "gettering." Ha (14a)

Tests of White Metals for Socketing Winding Ropes. JOHN WILSON. *Transactions Mining Institution of Scotland,* Vol. 54, 1933-34, pages 36-41; discussion, pages 47-49, 65-67. See *Metals & Alloys,* Vol. 5, July 1934, page MA 368. EF (14a)

Aluminum Overhead Transmission Lines in German Power Industry (Die Aluminium-Freileitung in der deutschen Elektrizitätswirtschaft). WARRELMANN. *Elektrizitätswirtschaft,* Vol. 24, Nov. 25, 1934, pages 489-491. Speaker before the Reichsverband der Elektrizitäts-Versorgung, Oct. 1934, offers evidence to show that Cu gives the best results as a cable material in electrical, mechanical, thermal, chemical and economical regard, but that national economy necessitates the adoption of Al for overhead transmission lines. Safety against failure is considered to be practically insured with Al cables reinforced by steel. Losses due to eddy currents and hysteresis in the steel reinforcement and danger of corrosion are pointed out. Al/steel cables are 65% more expensive than Cu cables of the same electrical properties. Owing to the present low international price of Cu and to German economic conditions the price difference rises to 93% with reference to "a 35 mm.^{2} Cu equivalency." Taking the installation expenses into account, some savings are effected by the combination Al/steel which cuts down the price difference to 20-25%. However with medium voltage lines the final price difference amounts to about 60% in favor of Cu. In this case the utilization of pure Al cables is recommended which cost 20-22% more than an electrically equivalent Cu cable. WH (14a)

The Application of Anodised Aluminium and Its Alloys. G. O. TAYLOR. *Metallurgia,* Vol. 11, Nov. 1934, pages 15-16. Anodically-treated Al is used as a corrosion-resistant and decorative material. It can be colored. Specific uses are mentioned. JLG (14a)

Aluminum as Material for the Electrical Equipment of Street Cars (Aluminium als Baustoff für die elektrische Ausrüstung der Strassenbahn). W. BENNINGHOFF. *Zeitschrift Verein deutscher Ingenieure,* Vol. 78, Nov. 24, 1934, pages 1385-1386. Tests in operation of street cars with the replacement of Cu by Al in coils, trolley wires and auxiliary devices are briefly reported. Definite conclusions are not yet drawn. Ha (14a)

Aluminum as Lightning Arresters (Aluminium im Blitzableiterbau). *Aluminium,* Vol. 17, Dec. 1934, pages 206-209. Advantages of Al in lightning arrester installations are pointed out, directions for their erection are given. Ha (14a)

Aluminium and Its Alloys in Buildings (Aluminium und seine Legierungen im Hochbau). *Aluminium,* Vol. 17, Dec. 1934, pages 155-158. Applications and methods of assembling of gutters, spouts, fixtures and roofing in buildings are reviewed. Al of 99.2-99.5% purity is usually employed. Ha (14a)

Aluminum in Switching Installations (Aluminium in Schaltanlagen). *Aluminium,* Vol. 17, Dec. 1934, pages 201-205. Advantages of Al over Cu are enumerated, properties of Al and Cu as materials in electric installations compared, methods for joining Al bus bars and wires described, and current capacities of wires, bars and tubes for different temperature rise given in tables. Ha (14a)

Antimony in the Enamel Industry. *Engineering,* Vol. 138, Oct. 19, 1934, page 428. Summary of facts from a report of the Minister of Health published in 1934 by H. M. Stationery Office entitled "Antimony in Enamelled Hollow-ware." Deals with the deleterious effect arising from the use of Sb oxide instead of Sn dioxide in enamels for utensils used for foodstuffs. LFM (14a)

Ford Building Metal Covered. *Heat Treating & Forging,* Vol. 20, Aug. 1934, pages 385-386. Similar to *Steel,* Vol. 94, June 25, 1934, pages 31, 51. See *Metals & Alloys,* Vol. 5, Oct. 1934, page MA 498. MS (14a)

Application of Capillary Metals Made By Sintering (Verwendung von durch Fritten gewonnenen Kapillarmetallen). *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Dec. 2, 1934, page 760. Capillary metals are made according to Uhlmann by sintering pressed metal powders in a high frequency field. These sintered bodies can be worked by any mechanical process. Among the applications suggested are (1) for bearings and (2) filtration of liquids, gases and vapors. GN (14a)

Importance of Hard Metal Tools for Craftsmen (Die Bedeutung der Hartmetallwerkzeuge für das Handwerk und die Installationstechnik). *Technische Blätter der deutschen Bergwerkszeitung,* Vol. 24, Dec. 9, 1934, pages 778-779. Discusses the manifold possibilities of application of hard metal tools by craftsmen, in working brick, concrete, glass, wood, etc. GN (14a)

Electrical Screw Machine Parts—How to Specify Them. HERBERT CHASE. *Electrical Manufacturing,* Vol. 13, July 1934, pages 19-22. Screw parts used in the electrical trade are described and machining difficulties outlined. WB (14a)

The Selection of Alloys for Die Casting. HERBERT CHASE. *Electrical Manufacturing,* Vol. 13, Oct. 1934, pages 13-15, 31. Zn base and Sn and Pb alloys are discussed. A complete table is given of all major A. S. T. M. and S. A. E. alloys with nominal compositions, physical properties and melting points. WB (14a)

The Use of Bright Metallic Surfaces for Increasing Human Comfort in the Tropics. G. P. CROWDEN. *Engineering,* Vol. 138, Oct. 12, 1934, pages 395-396. From paper read before Sub-Section AG of the British Association, Aberdeen, Scotland, Sept. 10, 1934. LFM (14a)

Aluminum Foil and Its Uses (Die Aluminiumfolie und ihre Verwendung). E. HERRMANN. *Aluminium,* Vol. 17, Sept. 1934, pages 15-19. Varied uses such as packing material in food and other industries, as labels, heat-insulating material, etc. are discussed and described. Ha (14a)

Progress in Production and Use of Light Alloys. C. C. HODGSON. *Metallurgia,* Vol. 11, Dec. 1934, pages 37-38. Use of Al and Mg alloys is reviewed. During the past year no radically new light alloys have found industrial application. JLG (14a)

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Wrapping of Apples in Aluminum Foil (Das Einwickeln von Aepfeln in Aluminiumfolie). E. HERRMANN. *Aluminium,* Vol. 17, Dec. 1934, page 190. Apples keep well in Al foil wrapping only when wrapped in such state that no moisture can condense on the fruit; otherwise the fruit will spoil much sooner than when not wrapped. Ha (14a)

Aluminum Has Made Rapid Strides in Railroad Rolling Stock Construction. T. H. GERKEN. *Iron Age,* Vol. 134, Aug. 2, 1934, pages 16-23, 66-68. Feature of the article is an extensive and detailed table giving a statistical record of the use of Al in railroad equipment. Includes discussion of the application of Al in railroad construction. VSP (14a)

The Beneficial Use of Tin Compounds in Lubricants. E. W. J. MARDLES. *Iron & Coal Trades Review,* Vol. 129, Oct. 26, 1934, page 636. See *Metals & Alloys,* Vol. 5, Dec. 1934, page MA 590. Ha (14a)

Aldrey as Trolley Wire (Aldrey als Fahrleitungsdraht). R. IRMANN & W. MÜLLER. *Aluminium,* Vol. 17, Nov. 1934, pages 142-147. When using aldrey instead of Cu for trolley wire the best sliding material (for roll or bow) is carbon with lubrication; also Cu-Al alloys with good lubrication have given satisfactory results. Test results with various combinations of materials are described. Ha (14a)

Platinum (Platin). KREUZKAM. *Die Umschau in Wissenschaft & Technik,* Vol. 38, May 6, 1934, pages 364-365. Commercial utilization, production and world prices during the past years. WH (14a)

14b. Ferrous

M. GENSAMER, SECTION EDITOR

Cast-Iron Block Pavement for Test Road in Minnesota. *Engineering News-Record,* Vol. 113, Nov. 8, 1934, page 599. The University of Minnesota laid a 30-ft. length of 24-ft. wide pavement with cast iron blocks on one of its campus streets. Blocks were triangular with diamond-shaped studs on the upper surface and were cored out and ribbed on the under side. They were 1⅞" high, 11⅛" on the sides at the top and 11¾" at the bottom. The full blocks weighed about 11 lbs. each. CBJ (14b)

Electrical Applications of Silicon Alloy Steels. WILLIAM C. HIRSCH. *Electrical Manufacturing,* Vol. 13, Sept. 1934, pages 25-26. Four new achievements in Si alloy steels now rolled in strip form are: iron losses lower, permeabilities higher, brittleness markedly reduced in best transformer grades, and reduced in others, surface and flatness are greatly improved. Strip is hot rolled and cold rolled to finish with heat treatment to relieve strains. Blanking and punching costs are high because of die wear for the higher Si alloys. Strip Si steels now on the market in coils 14 inches wide 22 to 30 gage. A normal year's consumption by electrical manufacturers is estimated as 300,000 to 350,000 net tons. WB (14b)

Stainless Steels in Aircraft Construction. W. H. HATFIELD. *Iron & Coal Trades Review,* Vol. 129, Dec. 28, 1934, pages 1018-1019. Developments in stainless steels since 1917 are reviewed and their properties, especially in welding and machining, and corrosion resistance discussed with regard to their application in aircraft construction. Requirements and regulations in Great Britain and some applications are briefly described. Ha (14b)

Heat-Treatment of Grey Iron Cylinder Liners. W. PAUL EDDY. *Industrial Heating,* Dec. 1934, pages 185-186. Machining, heat-treating and assembling operations as used for quantity production of cylinder liners is described. Ha (14b)

Durability of Hoisting Rope. JACOB FELD. *Civil Engineering,* Vol. 4, Dec. 1934, pages 647-648. Loss in strength of wire ropes may result from corrosion, worn wires, kinked wires, abrasion, cutting, fatigue, and crushing. Various rules affecting the replacement of ropes are discussed and some test data and service records tabulated. It is concluded that these are insufficient to enable reliable estimates to be made of the expected life of a hoisting rope. JCC (14b)

Pave Roads with Cast Iron Blocks. E. W. DAVIS. *Foundry,* Vol. 62, Sept. 1934, pages 24-25, 46, 48. See *Metals & Alloys,* Vol. 5, Nov. 1934, page MA 543. VSP (14b)

Cast Iron Test Pavement Laid. E. W. DAVIS. *Foundry,* Vol. 62, Nov. 1934, pages 32-33, 77. **Test Pavement Laid with Cast Iron Road Plates.** *Steel,* Vol. 95, Nov. 26, 1934, pages 30-31. Cast-Fe pavement, 30 x 24 ft., has been laid on the University of Minnesota campus, where traffic is heavy, for a practical demonstration of their wear and weather-resisting qualities. Blocks, of English design, are in the shape of an equilateral triangle, cored out and ribbed on the underside, and provided with diamond-shape studs on the upper surface. Composition of castings was varied, average lying between the limits 3.20-3.50% C, 2.70-2.95% graphitic C, 0.40-0.60% P, 0.09-0.125% S, 2.00-2.70% Si, 0.50-0.60% Mn, and 0.00-0.40% Cr. English castings contained much less P and had better impact strength, but would have been costly to duplicate. Describes methods of molding the blocks and laying the pavement. MS + VSP (14b)

"Flexible Tooth" Gears Operate Quietly. *Iron Age,* Vol. 134, July 12, 1934, page 29. Describes patented gears used in products of Root-Connersville Blower Corpn. Individual teeth are said to flex a fraction of a thousandth in. when they come in contact with a mating tooth. Metal used must be easy to machine and resist fatigue and wear. With a mixture of 40% steel, 1% Cr and 2% Ni giving a tensile strength of 42,100 lb./in.^{2} gears have shown practically no wear. VSP (14b)

Free-Machining Corrosion-Resisting Steels for Many Uses. EDWIN F. CONE. *Iron Age,* Vol. 133, June 28, 1934, pages 18-20. A description of the various properties and uses of Bethalons A and B of the Bethlehem Steel Co. The analyses of the two free machining steels are as follows:

	Bethalon	
	A	B
C	0.09 %	0.12%
Mn	0.37 %	0.22%
S	0.40 %	0.35%
P	0.012%	...
Si	0.49 %	...
Cr	12.48 %	18.60%
Ni	Trace	9.86%

VSP (14b)

Stelliting Valve Inserts on Internal Combustion Engines. *Machinery,* London, Vol. 44, July 19, 1934, pages 468-469. Heat treatment of cast iron cylinder lines and process of hard-facing valves with Stellite. WB (14b)

Production Methods and Materials in Boiler Construction (Verwaardigingswijzen en materialien in gebruik in den stoomketelbouw). *Polytechnisch Weekblad,* Vol. 28, Aug. 2, 1934, pages 488-489. Excellent tensile results on water-gas welded Mn-Si steels were obtained by the Mannesmann Co., which guarantees for the weld a yield point of 90% of the parent metal. Thyssen produces seamless rolled drums of Cu-Ni steel, while Krupp patented a Cr-Ni-Mo steel containing 2.3% Cr, 1.3% Ni and 0.3-0.5% Mo. Pressure tests at 120 atm. yielded good results. The joining methods (riveting, welding, rolling-in of tubes, flanging) are reviewed. A diagram according to Ott shows the ultimate strength of 29 commercial German boiler materials (analyses not given) and their yield point at 20°, 250° and 450° C. WH (14b)

The Conservation of Rail. Report of a Committee. *Railway Engineering & Maintenance,* Vol. 30, Oct. 1934, pages 561-563. Committee report covers mill practice (analysis, cooling, heat-treatment) rail laying, maintenance, rail end welding and grinding to overcome variations in height. WH (14b)

Rail Corrugation. A Difficult Unsolved Problem. *Railway Engineering & Maintenance,* Vol. 30, Sept. 1934, page 471. The cause of rail corrugation cannot be answered with authority as yet. Inferior rail material seems to be out of the question. The rigidity of the track structure may be an important contributing factor. Transverse corrugations on the treads of car wheels have also been advanced as the cause of this defect. A combination of factors such as high speeds, heavy loads, rigid track, improper locomotive counter-balance are supposed to be responsible. WH (14b)

Voting Machines—From Model Stage to Production Line. *Steel,* Vol. 95, Oct. 22, 1934, pages 29-33. Describes production of the Shoup voting-machine, manufactured by the Berger Mfg. Co., Canton, O., for the General Sales Engineering Corp., Philadelphia. Machine comprises approximately 17,000 parts, which are combined into 150 subassemblies and 13 major assemblies. Practically all parts are of steel in the form of cold-rolled sheet, strip, bars, bands, and flat wire. Fabrication involves many operations, including press work, welding, case-hardening, plating, and rust proofing. MS (14b)

White Castles Constructed of Porcelain Enameled Sheets. *Steel,* Vol. 95, Oct. 29, 1934, page 28. White Castle System, Inc., has standardized on porcelain enameled steel sheets for both interior and exterior walls of their eating houses. Patented key-locking device is used in assembly. MS (14b)

Experience with Steel Props of Wedge Type on Sections with Curved Flanges. R. C. WAIN. *Iron & Coal Trades Review,* Vol. 130, Jan. 4, 1935, pages 1-3. Results of 4 years' experience with steel props in mining operations are described; with discussion. Ha (14b)

Tool Steels—Their Composition and Use. F. D. STRANNER. *Heat Treating & Forging,* Vol. 20, Oct. 1934, pages 482-485. Paper read before the Steel Treatment Research Society, Australia. Deals with high-speed, non-deforming, and W-Cr steels, and with those used for molding dies. Describes heat treatment of the non-deforming tool-steels. MS (14b)

Permanent Way Engineering in North South Wales Railways. Some Incidents During 43 Years Professional Service. R. L. RANKEN. *Commonwealth Engineer,* Vol, 21, July 2, 1934, pages 375-386. Paper before the Institution of Civil Engineers, Sydney, Mar. 1934, reviews experiences on rail creep, rail joint welding, corrugated rails, rail grinding, rail lubrication, transverse fissures and electrically welded bridges. Strengthening and repairing existing mild steel bridges by electric welding has been a practice on the N.S.W. railways for some years since the locomotive and freight car axle loads increased 55 and 115% respectively. Inspection after 3 years service disclosed no weakness of any electrically welded reinforcement. The all-round economy due to elimination of joints by welding the rails together is stressed. The true cause for rail head corrugation has not been revealed. Some possible explanations are offered. Microscopic investigations showed that the surface had undergone distortions and severe plastic flow. After numerous trials, a compact and efficient track lubricator has been designed in order to reduce rail wear on special sections of the track. Rail wear is roughly proportional to wheel flange wear. Savings in one curve amounted to £870 due to increased life of 5 years. WH (14b)

Design and Use of Steel Mine Supports. WILLIAM REID. *Transactions Mining Institution of Scotland,* Vol. 54, 1933/34, pages 18-32; discussion pages 32-35, pages 63-64, pages 69-70. Based on several years' practical experience, the utilization of steel for sprags, face props, prop caps, straps, chocks and various possibilities of steel road supports are discussed in full detail. EF (14b)

Car Underframes made from Cast Steel. T. W. LIPPERT. *Iron Age,* Vol. 134, July 1934, pages 10-13, 84. Begins with a brief discussion of the development of steel castings in railroad car construction. Cast steel frames have performed satisfactorily in service and their use has resulted in lower operating costs. All laps, seams and joints are eliminated and just the required amount of metal can be placed at just the desired sections. Alloy cast steel shows a great advantage over C steel, hitherto used for underframes. Low Cr-Cu-Si steel and medium Mn steel have about five times the corrosion resistance of open-hearth steel. Many cores are used in various molding methods. Metal is poured at about 3000° F. at plant of General Steel Castings Corp. Oil-fired basic open-hearths are used. Charges consist of pig Fe and selected scrap. Steel poured has a C content between 0.15 and 0.20% and not over 0.06% P. Claims that next few years will witness evolution of revolutionary molding technique and reduced costs. VSP (14b)

Novel Concrete-Steel Constructions (Neue Beton-Stahlkonstruktionen). R. LEONHARD. *Zement,* Vol. 23, Apr. 26, 1934, pages 240-243. Points out that decisive progress in structural engineering can only be made if suitable combinations of steel and reinforced concrete members are developed. Some new experiments comprising I beams, and U channels, welded-on steel skeletons, and concrete are described. WH (14b)

Hoses for Gas, Water, Steam, Compressed Air, etc. Made of Hoop Steel (Aus endlosen blankgewalzten Stahlbändern gewickelte Schläuche für Gas, Wasser, Dampf, Pressluft usw). KAMMANN. *Kalt-Walz-Welt,* Oct. 1934, pages 75-77. Paper discusses in detail the various stages in processing hoses of hoop steel. GN (14b)

Cork and Steel Combined in Portable Houses for Alaska. ROBERT C. HILL. *Steel,* Vol. 95, Nov. 19, 1934, pages 33-34. Describes dwellings having steel frame and cork-board insulation. MS (14b)

Selection of Materials for Cast Valves and Fittings. A. M. HOUSER & H. L. MOE. *Steel,* Vol. 95, Nov. 26, 1934, pages 32, 34-35. For valves, C cast-steel is the most widely used even for temperatures as high as 1200° F., with suitable allowance for its loss of strength. An important use is in oil transmission lines within refinery limits. For high-pressure hydraulic work and oil cracking service, steels containing 0.75% C, 1.5-2% Ni, and 0.25% Mo are used. Cast-steel with 2-2.5% Ni is suitable for low temperature service. An economical steel for moderately high-temperature service is a C steel with 0.50% Mo. Steel with 4.5-6.5% Cr and 0.50% Mo is an economical corrosion-resisting material for oil cracking service. Various non-ferrous alloys are suitable for valve trimmings, depending upon service conditions, but most satisfactory material for valve-seats is a low-C, 12% Cr steel. MS (14b)

Gray Iron as Material for Glass Molds (Grauguss als Werkstoff für Glassformen). O. BORNHOFEN. *Glastechnische Berichte,* Vol. 12, Oct. 1934, pages 339-345. The valuable properties of cast Fe for use as glassmolds are pointed out. A plain cast Fe of fine grain is the most suitable for this purpose and can still be improved by small additions of Cr, Ni and Mo. A material of high Cr and Al content is most heat-resisting but not useful for glassmolds as it can not be machined. Ha (14b)

Oil Cracking Drums Made From Heavy Forgings. EDWIN F. CONE. *Iron Age,* Vol. 133, June 14, 1934, pages 22-24. Describes the manufacture of oil cracking drums, some of the advantageous properties and their applications in industry. Method is used by the Bethlehem Steel Co. VSP (14b)

Alloy Cast Iron, Used for Hydraulic Rams, Shows Uniform Texture. *Steel,* Vol. 95, Oct. 22, 1934, page 41. Barnett Foundry & Machine Co., Irvington, N. J., now uses Fe containing 2.96% total C, 0.74% combined C, 0.91% Mn, 1.46% Si, 0.102% S, 0.128% P, 0.58% Mo, 0.61% Ni, and 0.23% Cr. It is produced by normal cupola operating methods from a charge of 60% steel scrap, with scrap Fe, pig-Fe, and alloys constituting the remainder. Castings are uniformly fine grained, easily machinable, solid, and tough. Brinell hardness averages about 207. MS (14b)

15. GENERAL

RICHARD RIMBACH, SECTION EDITOR

Survey of Developments in Powder Metallurgy as it Applies to Ferrous Materials. CHARLES HARDY. *Steel,* Vol. 95, Nov. 19, 1934, pages 52, 54. Powder metallurgy has found a growing field in its application to ferrous metals, particularly in the mass production of small parts. Serious difficulties were encountered, but control over grain size, grain structure, and flowability has been achieved. So far costs have been relatively high. Great care is necessary to prevent inclusions, occlusions, and other detrimental features. Voids in parts which are not subjected to subsequent working after compression are likely to lead to trouble in heat treating. By rolling, drawing, or a second final compression, densities equal to rolled or forged metal can be obtained and voids eliminated. One of the greatest difficulties has been the selection of the type of C to mix with the Fe to obtain the desired C content. In the mass production of small parts, compression of powders in dies avoids machining operations and makes possible production of parts within specified limits. Individual powdered metals have been used as coatings on rods and sheets. Welding rods have been produced from powders of the various metals to which is added the necessary flux. Combinations of metals and non-metals can be made which are not possible in any other way. Greatest field is where new qualities can be given to the finished products and price is a minor factor. Powder metallurgy is relatively at the point reached by the alloy steel industry 10 years ago. MS (15)

Steel Progress. L. SANDERSON. *Electrical Review,* Vol. 115, Sept 7, 1934, page 304. Reviews recent developments of interest to the electrical industry. These include improved steels for hobbing of molding dies for plastics; an oil-hardening alloy steel which requires no tempering and a Cr-W steel, both of which are used for spindles of riveting machines in the rubber industry; increasing use of stainless steels, including those containing Se and Cb; rolling-mill rolls cast from steel with 3-3.5% Ni and 0.45-1.75% Cr; permanent magnets made from steels containing 10-25% Ni, 15-36% Co, and 8-25% Ti, and from sintered materials; steels with a high proportion of certain alloying elements, such as Cr, for Al die castings; and increasing use of heat treatment of steel castings. MS (15)

Compression, Tensile and Shearing Forces in Glass-Metal Joints (Die Druck-, Zug- und Schubkräfte bei Glass-Metallverschmelzungen). LISA HONIGMANN. *Glastechnische Berichte,* Vol. 12, Nov. 1934, pages 372-380. The conditions and the distribution of stresses when melting metal into glass or joining both materials by fusion were investigated. 25 references. Ha (15)

A New Analytical Method for Metal Industry. JULIUS GRANT. *Metal Industry,* London, Vol. 44, May 4, 1934, pages 459-460. New methods which involve new principles, even when limited in application, should be given serious consideration especially if small quantities are accurately determined. This method is termed "nephelometry." It is based on the precipitation reactions of metals, the precipitate being formed as a cloudiness which may be matched against that produced by a standard as in colorimetry. Great advantages are claimed for the method from the viewpoint of time required and ability to deal with small quantities. The essentials of the method are stability of cloudiness and homogeneity and reproducibility under standard conditions. The differences between the tubes required for this method and the usual Nessler colormetric comparison tubes are indicated. Suggestions for increasing the accuracy of the method are given. The photoelectric cell, which has the advantages of increasing the speed of working and independence of the human eye, is being applied. Some typical applications of the method are listed. It is suggested that possibilities for the use of the method exist wherever precipitation is involved and that it is frequently necessary only to determine the correct conditions to produce a non-coagulable haze. HBG (15)

The Damping Mass in Vibration (Das Dämpfungsmass bei Schwingungen). O. FÖPPL. *Mitteilungen des Wöhler-Instituts,* No. 23, 1934, pages 79-84. mathematical discussion of the various means by which vibrations may be damped. Primarily of mechanical interest, though the damping power of materials enters some of the formulae. HWG (15)

The Control of Industrial Dust. J. M. DALLAVALLE. *Mechanical Engineering,* Vol. 55, Oct. 1933, pages 621-624. Paper presented before Process Industries Division, A.S.M.E. Specifically discusses "the problem of local exhaust and general ventilation." MFB (15)

New Alignments Are Challenge to Industry's Technical Personnel. *Steel,* Vol. 95, Sept. 24, 1934, pages 37-40. Discusses realignment of materials, processes, and parts brought about through economic, scientific, social and other changes occurring during the depression period, with special reference to the metal working industries. MS (15)

What Canadian Copper Metallurgists Have Been Doing. R. E. PHELAN. *Mining & Metallurgy,* Vol. 15, Feb. 1934, pages 94-95. Describes the development during the past year in Canada. Developments in the line of new equipment and methods were a three-product flotation process for separating Cu, Zn and Fe from low-grade ore by the Britannia Mining and Smelting Co., a flotation concentrator and sintering plant to treat disseminated ores by Falconridge Nickel Mines, Ltd., and heating of air going to roasters by electrical heating elements at Flin Flon. Several other companies have reconstructed their equipment. New innovations in ore treatment increased employment. VSP (15)

Investigation on Disk-shaped Resonance Torsional Dampers at High Frequencies (Untersuchungen an scheibenförmigen Resonanz-Dreschwingungsdämpfern bei höheren Schwingungszahlen). E. KÜCHLER. *Mitteilungen des Wöhler-Instituts,* No. 23, 1934, pages 1-77. Mathematical principles and description of mechanical and electrical devices. Not metallurgical, but of interest to those concerned with the general problem of damping and damping properties. HWG (15)

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Flue Dust and Fumes in Metallurgical Plants (Flugstaub und Dämpfe in Hüttenwerken). GERHARD WOLFF. *Die Metallbörse,* Vol. 24, Oct. 20, 1934, pages 1337-1338; Oct. 27, 1934, pages 1369-1370; Nov. 3, 1934, pages 1401-1402; Nov. 10, 1934, page 1434. Treats the subject under the following heads: methods of flue dust recovery and flue gas purification, flue gases from metallurgical furnaces, cooling of gases by water, flue dust recovery by humidifying or treatment with chemicals, filtering, precipitation by impact on walls, reduction of gas flow velocity, precipitation by centrifugal forces, electric treaters, treatment with acid vapors, utilization of sulphurous acid fumes for making H_2SO_4, $NaHSO_3$, $CaSO_3$, $Na_2S_2O_4$, Na_2SO_4, H_2S, and S, utilization of HCl and Cl fumes. EF (15)

Non-ferrous Physical Metallurgy. ALBERT J. PHILLIPS. *Mining & Metallurgy,* Vol. 15, Jan. 1934, pages 39-45. Refers to important changes made in compilation and distribution of technical literature on the subject by the Institute of Metals, American Society for Metals and the American Institute of Mining & Metallurgical Engineers. Abstract service of *Metals & Alloys,* has been improved and expanded covering practically all phases of metallurgy. Developments of various non-ferrous metals are discussed: Aluminum by E. H. Dix, Jr.; Wrought Copper and Copper Alloys by D. K. Crampton; Lead and Tin by J. E. Harris; Zinc by W. M. Peirce; Secondary Metals by W. A. Scheuch; Precious Metals by E. M. Wise; Metallographic Instruments and Technique by Robert S. Williams; and Non-ferrous Foundry Practice by H. M. St. John. VSP (15)

Metallurgy of Zinc. E. H. BUNCE. *Mining & Metallurgy,* Vol. 15, Jan. 1934, pages 23-24. Continued progress in Zn metallurgy has been shown during 1933 by adoption of new methods as well as modernization of old processes and equipment, and initiation of new fields of activity for future advancement. Use of suspension roasting, developed by National Smelting Co., continued to grow. Improvement in business conditions increased price and demand for slab Zn. Silica brick as furnace lining came into general use. Tainton process for applying heavy coatings to wire marked another step in electrolytic development. Use of Zn of 99.99+ purity continued to increase. Use of Zn dust as a rust inhibiting priming coat for steel also increased. VSP (15)

Metallurgy of Gold. ALLAN J. CLARK. *Mining & Metallurgy,* Vol. 15, Jan. 1934, pages 25-27. Steadily rising prices for the metal have stimulated activity. Expansion affected every class of mine. Great emphasis has been placed on removal of as much Au from the ore as possible. Flotation is unquestionably the process of the moment. No unusual developments in reagents or machines have appeared during the year. Refers to several outstanding articles published in various technical journals on the subject during the year. VSP (15)

Production and Utilization of Slag Wool (Zur Herstellung und Verwendung von Schlackenwolle). BERNHARD WEBER. *Die Metallbörse,* Vol. 24, Oct. 27, 1934 pages 1370-1371. The utilization of slags from ferrous and non-ferrous metallurgical operations is a profitable by-product. Its usefulness is based on the favorable insulation properties which compare as follows with Cu: Cu = 1, bricks = 200, wood = 2000, sheep wool = 8000, slag wool = 10,000, air or any ordinary stationary gas = 20,000. Commercial utilization, former shortcomings, most suitable composition of slag, production methods of glass wool and recent American developments are discussed. EF (15)

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15b. Historical

Masterpieces of Old German Bronze Castings (Meisterwerke alt germanischen Bronzegusses). ERICH BECKER. *Technische Blätter der deutschen Bergwerkszeitung*, Vol. 24, Sept. 23, 1934, pages 606-607. Discusses the probable method applied in casting "Luren" that are horns made of bronze dating from 1500-1000 B.C. Analyses of different parts of such "Luren" excavated testify that the effect of Sn content on the melting temperature was known by that time in that the trusses subsequently cast around the horn tube possess highest Sn content and the chaplets lowest as table below shows.

Content %	Tube of lure	Trusses		Chaplets
		a	b	
Cu	85.03	80.92	80.98	88.46
Sn	13.76	17.26	17.29	6.08
Pb	.10	trace	trace	trace
Fe	.37	.30	.39	trace
Co	.54	.24	.27	—
As	trace	trace	trace	—
S	present	present	.22	present

GN (15b)

Ancients Manipulated Metals. H. E. WHITE. *Foundry,* Vol. 62, Feb. 1934, pages 36, 38. A historical discussion. Early writings show that foundry practice was one of the first of the mechanical arts. VSP (15b)

Production of Iron From the Oldest Times to the Middle of the 19th Century, With Particular Consideration of Luxemburg (Die Eisenerzeugung von den ältesten Zeiten bis zur Mitte des 19. Jahrhunderts unter besonderer Berücksichtigung des Luxemburger Landes). ANT. HIRSCH. *Revue Technique Luxembourgeoise,* Vol. 26, Sept.-Oct. 1934, pages 110-123. Historical outline with reproductions of old handmade ornaments of iron. Ha (15b)

Inception and Development of Hard Metal Carbides. KARL SCHROETER. *Iron Age,* Vol. 133, Feb. 1, 1934, pages 27-29. An authentic historical discussion of the original basic principles by the patentee of Widia cutting metal of the Krupp steel works. VSP (15b)

Early Malleable Days in Newark. GARDNER MEEKER. *Foundry,* Vol. 62, Feb. 1934, pages 46, 48. Mainly a historical discussion of the Meeker Foundry Co., Newark, N. J. VSP (15b)

Aluminum Cap Piece on Washington Monument. E. H. DIX, JR. *Metal Progress,* Vol. 24, Dec. 1934, pages 32-34. Recently discovered correspondence gives the reason for Al cap casting on Washington Monument as lightning protection. Price of 100 oz. casting in 1884 was $225 compared to present price of $.20/lb. WLC (15b)

Iberian Bronzes 3000 Years Old (Bronzes Ibères agés de trois mille Ans). J. R. MARECHAL. *Cuivre et Laiton*, Vol. 7, June 30, pages 273-274. Bronzes found in Spain had the composition 16.80% Sn, 1.40% Pb, 81.75% Cu. They were in excellent state of preservation, made by hammering, and show a structure of α and δ phases with a hardness of about 190 Brinell. Ha (15b)

The Oliver. Iron Making in the Fourteenth Century. RHYS JENKINS. *Transactions of the Newcomen Society for the Study of the History of Engineering & Technology,* Vol. 12, 1933, pages 9-12, Discussion pages 12-13, Correspondence page 14. Paper read at the Science Museum, London, traces literature statements on the Fe making in the fourteenth century with particular reference to the treadle hammer. WH (15b)

Do the claudiani carmina Mention Wire Drawing? (Erwähnen die claudiani carmina das Drahtziehen?) WILHELM THEOBALD. *Forschungen & Fortschritte,* Vol. 10, July 10 & 20, 1934, page 269. Critically discussing a Roman poem of 395 A.D., the author arrives at the conclusion that cold drawing of metals, particularly of Au, was unknown to the Romans. The production of Au threads is traced to having consisted of cutting of small strips from hammered Au foil. Later literature citations from the 10th and 17th centuries mention the same method. EF (15b)

A Note on Some Ancient Copper-coated Silver Coins of Cyprus. STANLEY G. WILLIMOTT. *Journal Institute Metals,* Vol 55, Advance Copy No. 683, Sept. 1934, 4 pages. A number of Greek and Roman coins found in Cyprus and having the appearance of bronze or Cu have been found to be a Ag-rich alloy coated with Cu. It is suggested that the coins as used did not contain the coating of Cu and that the Cu was deposited unintentionally by galvanic or electrolytic action. Experiments that demonstrate that the Cu could have been deposited by galvanic action are described. JLG (15b)

The early Casting of Iron—a Stage in Iron Age Civilization. T. T. READ. *Geographical Review,* Vol. 24, Oct. 1934, pages 544-554. Reviews archeology of cast iron in Greece, China, India. The usual idea that reduction of iron from ore was discovered by the Hittites and spread all over the ancient world from that origin is questioned. It was more probably discovered independently and almost simultaneously in Europe and China. Cast iron was produced in China on a considerable scale before wrought iron was, certainly in the second and possibly earlier than the sixth century B.C. The Chinese used coal rather than charcoal for reduction, having low-sulphur coal. The natives of Shansi still reduce iron in a primitive furnace which gives a malleable bloom, used for wrought products, and loose particles of iron which are mixed with coal and an iron phosphate mineral and melted for castings which contain 5 to 7% P, i.e., around the eutectic which melts at 980°C. While the early castings so far analyzed do not show high P, the same general method, without addition of iron phosphate may have been used in the earliest days. The Shansi coal contains P but is low in S, hence is not as suitable for making steel as for cast iron. The nature of local ore and fuel supplies affected the methods of iron production employed in different countries and Read believes that there were numerous discoverers of the processes instead of one original inventor. HWG (15b)

Phosphate Rust Protecting Processes (Parker and Bond). W. OVERATH. *Metallgesellschaft,* Sept. 1934, pages 12-16. A history of the development of protection of Fe against rusting by phosphates is given. Recent findings showed that the Romans used vivianite, an iron-phosphate mineral, for protection of iron utility objects. But only in the 19th century active surface treatment of metals started. Differences in the development in America and Germany of the Parker and Bond processes are pointed out. Ha (15b)

Early Iron Industry in Scotland. K. H. HUGGINS. *Iron & Coal Trades Review,* Vol. 129, Oct. 5, 1934, pages 493-494. Development and influence of natural advantages are described in an historical sketch. Ha (15b)

Works of the Park Gate Iron and Steel Company, Limited. *Foundry Trade Journal,* Vol. 49, Oct. 5, 1933, pages 187-189. Description, accompanied by 5 illustrations, of the works of the Park Gate Iron and Steel Company, Ltd., founded in 1823. It may be of interest that all the plates for the "Great Eastern" were made at the Park Gate works in 1854. OWE (15b)

Copper in Gold and Silver Coins and in Bullion (Le Cuivre dans les Monnaies d'Or, d'Argent et de Billon). V. BRIARD. *Cuivre et Laiton,* Vol. 7, Oct. 15, 1934, pages 455-457. A historical sketch outlining use of Cu as money and as addition to coins and Ag- and Au-ingots. Ha (15b)

On Early Welding at Krupp (Aus der Frühzeit des Schweissens bei Krupp). K. BÖHLE. *Technische Mitteilungen Krupp,* Vol. 2, Mar. 1934, pages 29-32. Discusses the development of welding by Krupp. Describes the various methods briefly. Historical. MG (15b)

News and Other Items

Supply of Iron Ore for 100 Years in Sight

The United States need not worry about becoming dependent upon foreign iron ore deposits to operate its great iron and steel industries for at least 100 yrs., notwithstanding estimates made several times recently, predicting a depletion of our ore reserves by about the year 1960. This statement was made by Carl Zapfee, a mining engineer of Brainerd, Minn., in an address before the American Institute of Mining and Metallurgical Engineers in annual convention at the Engineering Societies Building, New York City, Feb. 19.

"The collective effect of changes in practices, the political and economic reverses and the disclosure of new deposits during the last 20 years.," he said, "have indicated that the Lake iron ore region, chiefly the state of Minnesota, should continue for 121 yrs., and no doubt much longer. There is," he said, "about 1.46 billion tons of iron ore in reserve."

According to Mr. Zapfee, the depression has put a severe bend in production, having lengthened the life of the reserves at least 10 yrs. In his opinion, "40 to 45 million tons is apt to become a normal annual consumption in the future and the former 60 million ton shipments per year are probably past. The United States has always looked to the state of Minnesota for its iron ore deposits in the past and will have to do so in the future." For the 80 yrs. this area has been in production, it has supplied 80 to 85 per cent of the nation's total. Of the 160 ore producing units in the Lake region, 40 per cent treat their deposits to increase the grade, prior to shipment, the treated ore amounting in the last 10 yrs., to 34.8 per cent of the total.

Concluding his address, Mr. Zapfee stated that "the removal or reduction in the silica content of the ore has now become a basic requirement. The high-grade ores of the future will be obtained from high silica material, formerly disregarded, but now properly treated prior to shipment."

Petrographic Control in Steel Making

A quick glance through a translucent slice of rock slag, as thin as a sheet of tissue paper and mounted on a glass plate for better study under a powerful illuminated microscope, tells the story of what is going on in steel-making furnaces more accurately, more rapidly and more reliably than lengthy chemical analyses. Petrography, or rock picturing, is the term applied to this new practice, according to Earl C. Smith, chief metallurgist of Republic Iron & Steel Co., Youngstown, Ohio, who presented the annual Howe Memorial Lecture before iron and steel metallurgists at the meeting of the American Institute of Mining and Metallurgical Engineers in the Engineering Societies Building, New York City, Feb. 20.

If you watch the refuse or slag discarded from a steel furnace. Mr. Smith pointed out, the steel will take care of itself. At certain Republic mills, he said, the study of petrographs—rock pictures of the slag—had enabled the operators to increase production 2 to 3 per cent and get consistently uniform steel. In one case the yield of an open-hearth furnace was increased from 72 per cent to 85 per cent. Open-hearth furnaces ordinarily make 85 per cent of the American annual steel production of about 50,000,000 tons, so a 2 per cent increase throughout the industry would add about 850,000 tons to the annual production.

Some slags are white, some are light brown, others dark brown and a few jet black. In all the crystalline structure is different. The eye of the trained metallurgist, Mr. Smith stated, is quicker and more accurate than the hand of the chemist in determining whether the white hot metal in the furnace is going to meet specification weeks or months later when it enters industry as a steel product. Petrography has shown, he added, the degree to which steel is contaminated by the materials composing the furnace lining. What the steel industry needs, he concluded, are "fire and furnace bricks inert to molten metals and slags, insensitive to heat shock and capable of working at temperatures of 3500 deg. F. Needed also are the proper facilities for steel men to apply petrography intelligently to the control of all mill operations."

Standard Fuel Engineering Co. of 667 Post Avenue, So., Detroit, Mich., has installed a new rotary dryer. All clays used in the manufacture of its Zero cements are completely dried before being ground to the proper mesh.

Engineering Uses of Modern Cast Metals

The American Foundrymen's Association is doing fine work in bringing reliable information on the properties of modern castings to the attention of the engineers and designers who specify castings and fix the design loads.

One of the steps in this program of mutual education of the engineer as to what the metallurgist can supply, and of the metallurgist as to what the engineer wants in castings and how he is using them, will be taken in Chicago, on March 18, when a session on "Engineering Uses of Modern Cast Metals" is to be held under the auspices of the Chicago sections of the A. F. A., the A.S.M.E. and the Western Society of Engineers.

Advancements made in the engineering properties and uses of steel, malleable iron and gray iron castings will be reviewed by such leaders in these fields as H. Bornstein, chief chemist and metallurgist, Deere & Co., Moline, Ill.; D. P. Forbes, president and general manager, Gunite Foundries Corp., Rockford, Ill.; and A. N. Connarroe, metallurgist, National Malleable & Steel Castings Co., Melrose Park, Ill.

An exhibit, intended to represent the uses of modern cast metals in various industries—agriculture, automotive, railroad, steel and so on—will open at 6:45 p. m. for inspection prior to the session which will be held at 7:30 p.m. in the auditorium of the Engineering Building.

Directors Selected for Houghton Company

Announcement is made of the following election of directors by stockholders of E. F. Houghton & Co., 240 W. Somerset St., Philadelphia, Pa., at their annual meeting: Louis E. Murphy, Maj. A. E. Carpenter, George W. Pressell, Dr. R. H. Patch, A. E. Carpenter, III, H. B. Fox, and C. Howard Butler.

At the organization meeting of the board of directors the following officers were re-elected: Chairman of the board, Louis E. Murphy; president, Maj. A. E. Carpenter; vice-president, George W. Pressell; treasurer, Dr. R. H. Patch; secretary, A. E. Carpenter, III; assistant secretary, Charles P. Stocke; and assistant treasurer, M. M. Menningen.

Case Hardening Service Co., 2281 Scranton Road, Cleveland, Ohio, has been appointed by the Hevi Duty Electric Co. of Milwaukee, Wis., as district representative for the State of Ohio. They will have charge of the company's service and sales agency on electric heat-treating furnaces.

Sylvester A. Mahan has been appointed works manager of the Philadelphia plant of the Edward G. Budd Mfg. Co. and Joseph W. Meadowcroft, assistant works manager. Earl Blaine has been appointed chief inspector.

The **C. H. Dockson Co.** of Detroit, Mich., announces that **William Zorn,** formerly welding engineer for the Detroit Edison Co., joined their organization in the capacity of consultant welding engineer, Feb. 1. Mr. Zorn's services, as a consulting engineer or as a speaker, will be available to anyone with arc welding problems in the middle west. His experience embraces nearly every phase of metallic arc and gas welding. He is an active member of the American Welding Society.

The **Meehanite Metal Corp.** of America, Pittsburgh, announces that the following foundries have now taken out licenses to manufacture all grades of Meehanite Metal: Warren Foundry & Pipe Co., Phillipsburg, N. J.; The Wehrle Co., Newark, Ohio; Florence Pipe Foundry & Machine Co., Philadelphia, Pa.; G. M. Hay Co., Glasgow, Scotland; and Etablissements Zickel-Dehaitre, Paris.

The Annual General Meeting of the American Iron and Steel Institute has been scheduled for May 23, in New York.

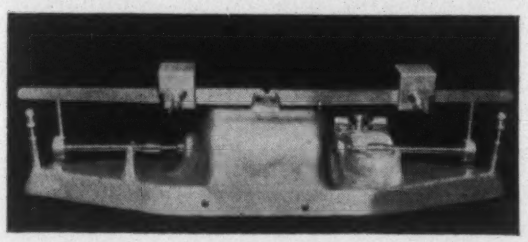
At their annual meeting, the directors of the **Udylite Co.,** Detroit, Mich., elected **L. K. Lindahl** vice-president and general manager of the company. Mr. Lindahl's appointment comes after 12 years of association with the company.

NEW EQUIPMENT & MATERIALS

Krouse High-Speed Repeated Stress Machine

A new type high-speed repeated stress machine has been developed to meet the demand for a rapid, dependable and inexpensive method of determining the endurance limits of metals.

The test results obtained with this machine are claimed to be directly comparable with results obtained with the slower and more expensive machines. It has been found, by a number of investigators, that the specimen size has no appreciable effect on endurance limits. The same number of cycles will determine endurance limits at testing speeds of 10,000 rpm. as are required at the slower speeds.

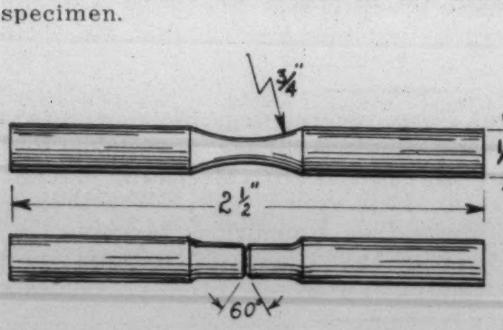


In the machine shown in the illustration, two independent specimens, stressed as rotating cantilever beams, are driven by a directly connected electric motor at 10,000 rpm. A simple specimen is held in a chuck on either end of the shaft of the inclosed motor. The other end of the specimen is held in a chuck on one end of a bending arm. The free end of this arm rotates in a shielded ball bearing carrying the weight of one end of the scale beam directly above.

The scale beam, carrying a movable weight, is graduated in inch-pounds of bending moment. The only measurement necessary is that of the diameter of the reduced section of the specimen. The stress in the specimen is computed by the simple flexure formula.

The cycles of stress applied to each specimen are recorded on separate counters, each recording to 100 million cycles. When either specimen fractures, that specimen's counter is disengaged. The last specimen to fail stops the motor. A toggle switch is provided for manual control. Two guards restrain the bending arm after the specimen has fractured.

The dynamically balanced motor is designed for continuous high speed service and operates on 110 volts ac. or dc. This motor is so rigidly mounted in the main casting that the sudden release of load, due to specimen failure, does not affect the stress in the other specimen.



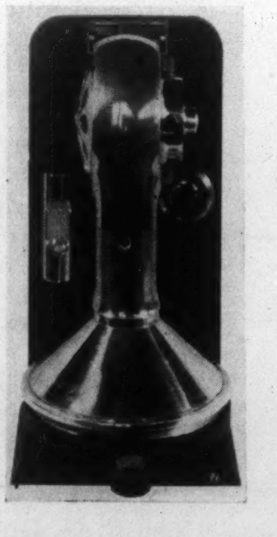
A few drops of oil applied to each of the four ball bearings after every 100 hr. of use, provides sufficient lubrication for satisfactory service. The machine is 28 in. long, weighs less than 30 lb. and requires no special stand or fastenings.

Two types of specimens have been adopted which give important properties of the metal under test. The endurance limit of a material, with the surface finish approaching the ideal condition, is seldom the true measure of the maximum usable stress under service conditions. The stress concentrations due to tool marks, holes and sharp notches are especially pronounced in some metals and should be considered in the selection of a material where repeated stress is the governing factor. The polished specimen, shown in another illustration, will give the endurance limit of a metal having almost ideal surface conditions, while the notched specimen shows the susceptibility of the metal to inferior finishes. Surface conditions in actual service lie somewhere between these two extremes. These two simple specimens are easily and accurately machined from small amounts of metal, hence are inexpensive. Specimen costs are important to most investigators as an endurance limit determination requires from four to eight specimens on any type machine.

The machine has been developed by G. N. Krouse, 1737 Freeport Road, New Kensington, Pa.

New Device for Testing Sand

A new development in sand testing is offered by the Harry W. Dietert Co., Detroit, Mich. It has been given the name of "Moisture Teller." The new instrument, it is claimed, will dry a 50 gram sand sample at 212° F. in 45 seconds. The sand sample is weighed before and after drying. The moisture determination is made in percentage and checks exactly with the standard oven moisture test. The "Moisture Teller" needs no calibration and is not affected by condition of the sand. Its great speed does not affect the accuracy of the test. It consists of a cast aluminum base on which is mounted a motor-driven blower forcing air over an electric heating element. The heated air flows through the sand sample inasmuch as the sample on which moisture is being determined is contained in a pan having a Monel metal filter cloth bottom. The sand pan is held against the bottom flanged portion of the air tube by means of a spring loaded holder. Three sand pans are furnished with the unit enabling the operator to weigh sand samples while the unit is drying a sample. The "Moisture Teller" will dry samples as fast as an operator can weigh out sand samples. It may be used at any convenient location in the plant where electric current is available. The current consumption is 5 amps. It weighs 8½ lbs. and has an overall height of 11 inches. No preheating period is required. It may be used to make moisture tests of sand from a floor where the temper of sand is questioned, or located beside the conveyor belt to check moisture, or located in a laboratory. Moisture determination may be made of any granular material such as molding and core sand mixture, clays, coal dust, flour and refractory mixtures.



"Hommelaya," A New Enameling Process

The answer to every manufacturer's hope—a better product at a lower unit cost—is said to have been discovered for the enameling industry in a new and basically different process.

The process was developed through the joint efforts of Dr. J. E. Rosenberg, director of research for the O. Hommel Co., of Pittsburgh, and William J. Baldwin, incumbent of the industrial fellowship established by the company at Mellon Institute, Pittsburgh. It results in a new type of porcelain enamel product which will be known under the trade name of "Hommelaya." Patents have been granted or are pending in the United States and foreign countries.

Porcelain enamels are important to a wide range of manufacturers, and particularly so to makers of electric refrigerators, kitchen ranges, washing machines and cooking utensils. In these products porcelain enamel covers all or much of the visible surfaces. Taking a tip from automobile makers, manufacturers of products for the home have found smart design and surfaces finished in smooth, gleaming white or gay pastel shades a potent selling appeal to the housewife who now demands beauty in the kitchen as well as in the living room of her home.

Consequently great pains have been taken with finishes, and in the heavily demanded white or pastel tints three successive coatings and firings of enamel have been necessary. According to Dr. Edward R. Weidlein, director of Mellon Institute, in addition to meeting or improving standards in all other respects, the Hommelaya process achieves a greater degree of opacity, and therefore depth of color, in two coatings and firings than are possible with three in present processes.

To the manufacturer the new process brings the following advantages: (1). A better product, less liable to craze or chip. (2). An important saving in cost of materials per unit. (3). A decrease of 33 1/3 per cent per unit in fuel and labor costs incidental to firing. (4). A 50 per cent increase in productive capacity of present kiln equipment. (5). A smaller number of rejected units due to the elimination of the hazard of the third firing.

Although the product coated with Hommelaya Porcelain will require only two coatings in place of the three now current, it is pointed out that the third coating, necessary under the present practice of using a blue ground coat, is applied only to secure the required degree of opacity and adds nothing to the strength nor wearing quality of the product.

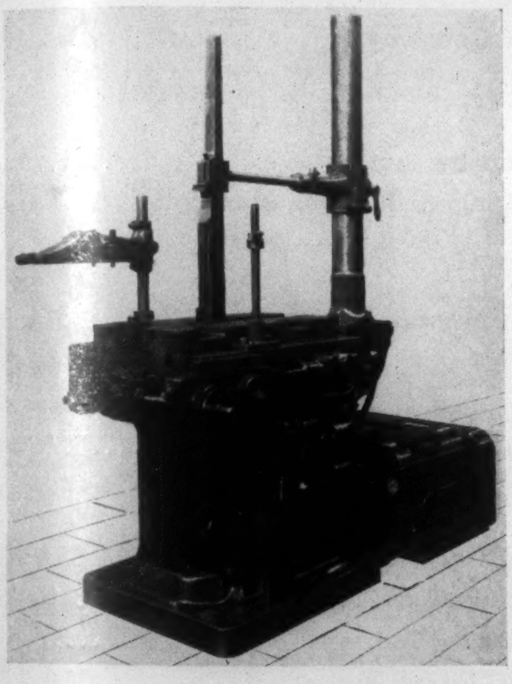
A great many enameled products have sheet steel as the base material. In enameling, the sheet is immersed or sprayed with a "frit" which is really a form of glass, finely ground and suspended in a liquid. When the liquid has evaporated leaving the frit evenly deposited upon the sheet metal, the product is fired.

The problem in enameling is to secure a firm bond between this first or "ground" coat and the steel. This is accomplished by the addition of chemicals which act similarly to a flux in the welding of metals. Through the action of these chemicals, under present methods this "ground" coat is either black or very dark blue, and two additional coatings and firings are needed to prevent the dark "ground" color from showing through and altering the surface color. With the Hommelaya process, a white or a light color can be secured in the "ground" coat, and therefore only one additional coating and firing is needed to secure a true color tone.

The success of the laboratory experiments of Mellon Institute has been confirmed by use of the process under actual industrial conditions in several manufacturing plants. The process will go into commercial use in the near future.

New Stationary Keyway Cutter and Slotting Machine

The new Morton stationary keyway cutter and slotting machine is a patented design wherein the work remains stationary at all times. The correct adjustment for taper, depth of cut and cutting of keyways in taper bores comes in the guides, cross head and cutter bar member. The machine consists primarily of four major units: The top plate, the guide and cross head unit, the column and the driving unit. The top plate is rectangular in shape with a large surface. It is "T" slotted on the top surface. It is heavily ribbed and cross ribbed and is provided on the lower side with a carefully machined and fitted bearing surface. It bolts rigidly to the supporting column. An auxiliary top plate is used between the main top plate and the work, primarily as a protection in the handling of heavy work.



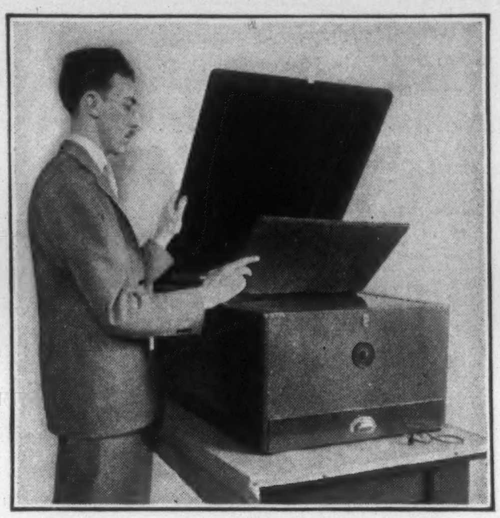
The guide contains all of the gearing for transmitting the power to the spiral cut pinion and rack which reciprocates the cross head and the cutter bars. This guide is journalled in a special trunion member. A positive means is provided for locking the guide with the trunion member.

The column is a box shape casting heavily ribbed to support the top plate and the heavy loads such as flywheels, propellers and other heavy work. The shifting and stroke adjusting mechanism is attached to the column and is driven through a universal shaft from the lower extremity of the guide.

The driving unit consists of a gear box in which two clutches running in opposite directions run in a bath of oil. Reciprocation is obtained by means of engaging one or the other of the clutches. This motion is transmitted to the guide of the machine by means of a universal joint spline shaft. The cutter bars are made of a rectangular section, heat-treated steel forging proportioned for maximum stiffness. This new stationary keyway cutter and slotting machine can be furnished in sizes ranging from 30 to 60 deg. of cutting stroke, by the Morton Mfg. Co., Muskegon Heights, Mich.

The Blueprinter

A blueprint machine, which utilizes the new Angstrom Blueprint Lamp, has been placed on the market by Milligan & Wright Co., 4713 Prospect Ave., Cleveland, Ohio. The Angstrom lamp used in this machine is of the incandescent type and as such offers many advantages over the conventional arc and mercury vapor lamps. It operates from the regular 110-115 d.c. or a.c. lighting circuit without the need of transformer choke coils, etc. It differs from the ordinary incandescent lamp in the quality of light produced, being stronger in the blue end of the spectrum. The model, No. 100, here reproduced, is the portable table type which will print one 18 x 24 in., or two 12 x 18 in., or four 8 x 12 in. prints at one time. Additional features are that one print can be made as economically as a dozen, it can be operated by anyone without danger of accident or fire, and no special electrical equipment required—just plug it in any where.



Corrosion-Proof Dryers of Aluminum Construction

Corrosion and rust are accelerated by the hot, humid atmosphere necessarily prevailing in drying machines. With machines of ordinary iron and steel construction, the corrosion in some cases is sufficient to shorten the life of the equipment; while, in other cases, it will seriously impair the quality of the product, a few small particles of rust being sufficient to contaminate pharmaceuticals or to cause trouble in the drying of textiles. Therefore, to eliminate all danger of corrosion, The Philadelphia Drying Machinery Co., Philadelphia, has developed a dryer of aluminum construction.

The first step in providing thorough protection was the use of aluminum heating coils. This proved of great advantage because it eliminated one large source of contamination from rust particles, in addition to providing better heat transfer due to the high conductivity of the aluminum.

Structural aluminum is used throughout for the frame, making a lightweight structure practically as strong and rigid as the steel frame which it replaces. Aluminum sheets are used for all internal partitions, as well as for the inside sheets of all insulating panels. Steam coils and coil supports are also of aluminum construction. Aluminum bolts are used to assemble the framework. All surfaces which come in contact with the recirculated, heated and humid air are of aluminum or aluminum alloy construction. In selecting the alloys of aluminum for this purpose, care was exercised to use alloys free from copper, as these alloys had previously been proven unsatisfactory.

Naturally, this construction is considerably more expensive, but the added cost is justified in lower maintenance costs and freedom from corrosion, longer machine life, and entire elimination of the possibility of contamination of product.

New Line of Convertible Motors

An entirely new line of convertible squirrel cage and slip ring induction motors, offering all standard frequencies for service ranging from 110 to 220 volts, has been announced by the Harnischfeger Corporation, West National Avenue, Milwaukee, Wis.

Built in accordance with the standards adopted by the National Electrical Manufacturers Association, the outstanding feature of these new P. & H. motors is their ready convertibility from open type to fan cooled, splash proof or totally enclosed construction. This is accomplished through the design of the frame, end heads and bearings to permit interchangeability in the four above mentioned types of single or multi-speed squirrel cage and slip ring motors.

This development in standard AC motors is especially significant to machinery manufacturers because of the adaptability of these units to various service requirements.

Among the other interesting features is the unique mounting of the stator laminations which are stacked between heavy steel end rings and the entire assembly then welded to the frame. This construction is claimed to provide absolute rigidity and make it impossible for the stator core to shake loose. The rotor windings are assembled from round or rectangular hard drawn copper bars which are placed in the rotor slots without insulation or slot wedges. The ends of the bars are brazed to the end rings by an electric arc torch.

Flexible Seamless Connections with Brass Bracket Support for Movable Platen Presses

The American Brass Company, Waterbury, Conn., announces a new brass bracket which is a patented feature of the company's latest product—American flexible steam connections for movable platen presses. Designed by the company engineers the product is a combination of American flexible seamless tubing and the brass bracket support. The flexible tubing, the conducting element of the assembly, is seamless and free from welds, joints, seams, laps, or packing. It is made from a drawn tubing of special bronze. Deep helical corrugations, die-formed into the tubing, impart the necessary flexibility. The bracket is attached to the flexible tubing in such a manner that flexing of the tubing is equal at all points and the tubing is held constantly in a horizontal position thus preventing sagging and the possibility of water pockets forming. The assembly is applicable to either series or individually connected platens, and manufactured in popular sizes for every travel

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